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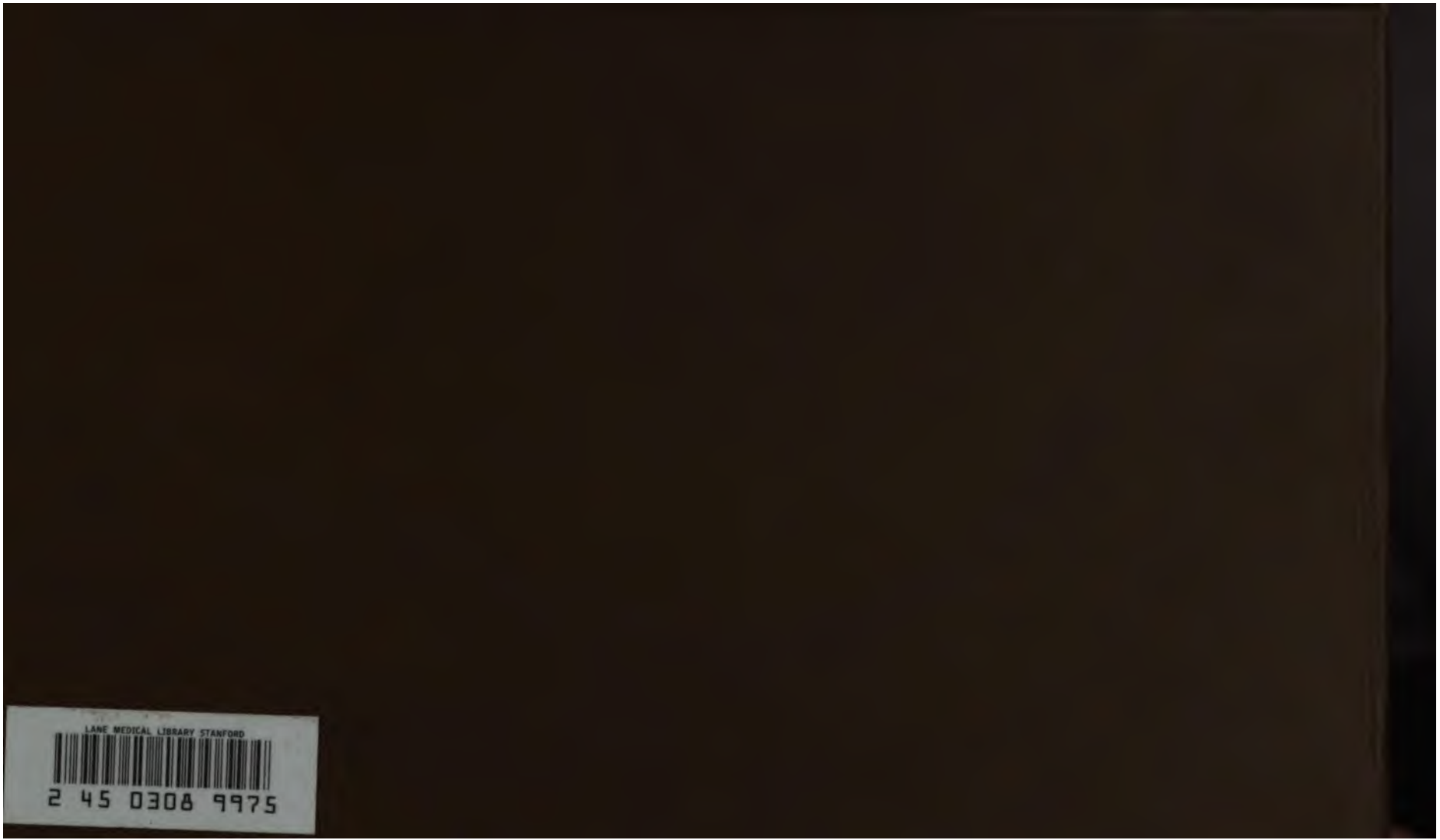
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The Influence of the Male Element

UPON THE

FEMALE ORGANISM,

OVER AND ABOVE ITS FERTILIZING INFLUENCE UPON THE OVUM.

BY

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GLASGOW, SCOTLAND.

10—1

THE INFLUENCE OF THE MALE ELEMENT UPON THE FEMALE ORGANISM.[1]

THE subject of this paper is rather outside the category of this Society, and is unsatisfactory so far as it has no claim to be practical. It is one on which Alexander Harvey, of Aberdeen, has at various times written, and his essays have quite recently been published in book form. The late Charles Darwin, in his work on the "Variations of Animals and Plants under Domestication," has a great deal to say on this subject. In that work he speaks of the principle of inheritance, and refers to the great variability of this inheritance, due to the immense number of causes, known and unknown, which act and react upon the organism during its various stages of life. The influence of the male element upon the female organism, over and above its fertilizing influence upon the ovum, he considers an important cause in the variation of inheritance. Darwin has given proofs of this influence in both vegetable and animal life, but Harvey has limited his proof to the higher animals and man. He, however, believes that pathological qualities may be transmitted in this way, and has brought forward evidence in support of that view. Harvey and Darwin do not agree regarding the route of transmission of this influence, but this will become more evident as we proceed. The major portion of this evidence has been taken from these two authors.

First, as regards the evidence from vegetable life, Sachs, in his recent work on botany, says: "The process of development brought about by fertilization, or the union of the reproduc-

tive cells, is usually not confined to the resulting embryo, but shows itself also in a variety of changes in the mother plant itself;" and he gives various examples. He says, "In phanerogams the entire development of the seed and fruit depends upon the changes caused in the mother plant by the fertilization of the embryonic vesicles. In the *orchidaceæ* the action of the pollen tube is visible on the mother plant even before fertilization. Hildebrand has shown that in all orchids that he examined the ovules were not in a condition to be fertilized at the time of pollination, and in some, as *Dendrobium nobile,* they have not even begun to be formed. In the orchidaceæ the formation of the female cell is therefore a result of pollination. It is determined by the action of the male pollen tube on the tissue of the mother plant."

Darwin has also given a good many instances to show this influence of the male element upon the mother form. He says that in plants the ovarium and the coats of the ovules are obviously parts of the female, and he gives evidence to show that these are affected by foreign pollen. "It was observed," he says, "as long ago as 1729 that white and blue varieties of the pea when planted near each other, mutually crossed, no doubt through the agency of bees, and in the autumn blue and white peas were found within the same pods. It has been conclusively proved since, by the experiments of Gaertner and J. M. Berkeley, that the color of the skin of the pea is modified when pollen of a differently colored variety is used."

He quotes also the case of the tall sugar pea, which bears very thin green pods, but when fertilized with pollen of the purple-podded pea it yields a pod clouded with purplish red. The color lies in the outer of the two coats which surround the pea.

Further, he proceeds to show that this influence may extend also to the ovarium and fruit. "Gallesia," he says, "impregnated an orange with pollen from a lemon, and the fruit borne on the mother tree had a raised stripe of peel like that of a lemon, both in color and taste, but the pulp was like that of an orange, and included only imperfect seeds."

"M. Naudin," he says, "states that he has seen fruit growing on *chæmærops humilis* which had been fertilized by M. Denis with pollen from the *phœnix* or date palm. The fruit or drupe thus produced was twice larger and more elongated

than that proper to the *chœmœrops*, so that it was intermediate in these respects as well as in texture between the fruit of the two parents. These hybridized seeds germinated and produced young plants likewise intermediate in character."

He then gives similar cases among the *cucurbitaceæ*, grapes, maize, and apple.

Now, it is has been shown in these cases that the influence of the male element represented by foreign pollen caused the production, in some cases, of imperfect seeds, in others of perfect seeds, leading in the case of the perfect seeds to the development of hybrid plants. But over and above this influence, it exerted another over parts purely maternal, and having nothing to do with the embryo, such as the seed coats of the pea, and the various fruits mentioned.

But it has to be noted that in the cases given the changes produced in the maternal parts were due to fertilization by foreign pollen. When pollen from the same species is the fertilizing medium, we get what is an ordinary event in nature, the seed or fruit shows no divergence from what is usual to the plant. There is an attempt by nature in both cases to incorporate the qualities of both male and female elements. When foreign pollen is used we have divergent results in the seed or fruit, because there is an attempt for each element to be represented in the product, and the degree of representation depends upon whether the one or the other is prepotent.

What pollen of the same species is used, where male and female attributes coincide, there is no evidence that the male element has any influence over purely maternal parts; but may we not naturally conclude that there is such an influence by analogy from these cases where foreign pollen is used? To deny this, we must believe that foreign pollen has an influence which is denied to pollen of the same species.

Regarding the extent of this influence in plants, Darwin says that while foreign pollen may cause the coats of the seeds and the ovarium or fruit, and even the calyx and upper part of the peduncle of the mother plant, to be modified, yet he has no reason to believe that this influence extends any further into the plant. There is not the least reason to believe, he says, that a branch which has borne seed or fruit directly modified by foreign pollen, is itself affected so as subsequently to produce modified buds. Such an occurrence, from

the temporary connection of the flower with the stem, would be hardly possible.

But it may be asked—if there is no reason to believe that the tree itself, or even the branch, is modified when the flower produced upon it has been fertilized by foreign pollen, on account of the temporary connection of the flower with the stem, would a modification not be expected in other and higher organisms from a similar influence where the ovarium is not temporary but permanent?

Darwin has given cases to show that a variety, when grafted or budded on another variety, sometimes affects the whole stalk, or at the point of junction gives rise to a bud or graft hybrid which partakes of the characters of both stock and scion. For instance, when the variegated jasmine is budded in the common kind, the stock sometimes produces buds bearing variegated leaves. This has also been seen in the oleander. Some buds of a golden variegated ash, which were inserted into common ashes, all died except one; but the ash stocks were affected, and produced—both above and below the points of insertion of the plates of bark bearing the dead buds—shoots which bore variegated leaves. Buds taken from an ash tree with yellow leaves were inserted into common ashes, which in consequence were affected, and produced the blotched Breadalbane ash.

These cases most undoubtedly show that grafts exercise an influence upon the mother stock, probably of the same nature as the influence of the male element upon parts maternal—proceding, however, in the case of grafts, to exercise that influence to a wider extent, on account of their more permanent connection with the mother plant.

Now, as regards the evidence from animal life. That evidence may be shown in the transmission of physiological and pathological qualities; and, first, as regards the physiological qualities.

In the "Philosophical Transactions" for 1821 two cases are recorded which have been quoted both by Dr. Harvey and Darwin. They are as follows:

A nearly pure bred Arabian chestnut mare bore a hybrid to a quagga; she was subsequently sent to Sir Gore Ouseley, and produced two colts by a black Arabian horse. These colts were partially dun-colored, and were striped on the legs

more plainly than the real hybrid, or even than the quagga. One of the two colts had its neck and some other parts of its body plainly marked with stripes. Stripes on the body, not to mention those on the legs, and the dun-color are extremely rare with horses of all kinds in Europe, and are unknown in the case of Arabians. But what makes the case still more striking is, that the hair of the mane in these colts resembled that of the quagga, being short, stiff, and upright. Hence there can be no doubt that the quagga affected the character of the offspring subsequently begot by the black Arabian horse. A sow of the black and white breed (known as Mr. Western's breed) became pregnant of a boar of the wild breed, of a deep chestnut color. The pigs produced were duly mixed, the color of the boar being in some very predominant. The sow being afterward put to a boar of the same breed with her own, some of the produce were observed to be stained or marked with the chestnut color that prevailed with the former litter; and on a subsequent impregnation, the boar being still of the same breed as the sow, some of the litter were also slightly marked with the chestnut color.

Other cases are given by Dr. Harvey which need not be repeated, as they resemble the previous two cases. The following two cases occurred in the human species, and are also from Dr. Harvey's work.

Mrs. —— was twice married, and had issue by both husbands. The children of the first marriage were five in number, of the second, three. One of these three (a daughter) bears an unmistakable resemblance to her mother's first husband. What makes the likeness the more discernible is that there was the most marked difference in their features and general appearance between the two husbands.

Professor J. Y. Simpson communicated to Dr. Harvey the following case: A young woman, born of white parents, but whose mother some time before her marriage had a bastard child (a mulatto), by a negro man-servant in Edinburgh. She presented distinct traces of the negro. Dr. Simpson had no recent opportunities of satisfying himself as to the precise extent to which the negro character prevails in her features, but he recollects being struck with the resemblance, and noticed particularly that the hair had the qualities characteristic of the negro.

Dr. Harvey says these facts were well known to our great breeders of cattle, dog fanciers, etc., and also to the Arabians. Darwin mentions, in a footnote, that a French poet, Jacques Savary, who wrote in 1665 on dogs, was also aware of it. Beeker, in 1703, seems also to have been aware of it, and accounted for it as being due to maternal impression. "When a mare," he says, "has had a mule by an ass and afterward a foal by a horse, there are evidently marks in the foal of the mother having retained some idea of her former paramour, the ass." Haller was also acquainted with a similar case, but accounts for it by a permanent impression made by the semen of the male on the genitals, and more particularly upon the ova of the female. This theory was adopted by many physiologists.

The influence of the male element in these cases has been compared to what is seen in birds, where a single intercourse is known to impregnate many eggs which are laid successively after it, or among the aphis, where the production of young by the female goes on for several generations without any sexual intercourse after that which gave rise to the first. Sir Everard Home, in discussing the cases reported in the "Philosophical Transactions" for 1821, believed them to be due to an abiding influence exerted by the male on the imagination of the female, and operating on her mind at the time of her connection subsequently with other males, and perhaps during her pregnancy. He further seems to have satisfied himself of the existence of nerves in the placenta, and that there was a nervous connection between mother and fœtus through the umbilical cord. This discovery has not been corroborated by succeding observers.

Dr. Alexander Harvey, of Aberdeen, adopted the theory of Mr. James M'Gilvray, a veterinary surgeon of Huntly, and quoted from the "Aberdeen Journal" of 21st and 28th March, 1849. This theory Dr. Harvey has named that of "fœtal inoculation." He believes that the effect is due first to the influence of the male on the ovum, which, in consequence of the subsequent close attachment and freely intercommunicating blood-vessels between the modified embryo and the mother, inoculates the constitution of the mother with the qualities of the male, and so on a subsequent impregnation by another male, the offspring resembles the first male, and not its real parent. He even goes further, and says that it is conceivable,

by each successive impregnation effected by him, that influence may be increased, and if so, the younger children begotten by him, rather than the elder, might be expected, *cæteris paribus*, to bear their father's image, and as regards the mother he suggests the question as to whether there is not something in the popular notion that in the course of years a woman comes to resemble her husband, and that not merely in respect of temper, disposition, or habits of thought, but in bodily appearance, which may be referable to this influence exerted by the husband through the medium of the several fœtuses *in utero* on her constitution.

Darwin, on the other hand, considers it a most improbable hypothesis that the mere blood of one individual should affect the reproductive organs of another individual in such a manner as to modify the subsequent offspring. The analogy, he says, from the direct action of foreign pollen on the ovarium and seed coats of the mother plant strongly supports the belief that the male element acts directly on the reproductive organs of the female, and not through the intervention of the crossed embryo. But, at the same time, while having a preference for this explanation, he says, if the influence be admitted as passing through the fœtus, the case would become one of graft-hybridism, for the fertilized embryo and the mother plant must be looked upon as distinct individuals. The only difficulty here seems to be that in plants the ovum or seed is inclosed in the ovary, and, therefore, the action of the pollen may affect both; but it is difficult to account for the male elements affecting the ovarium of animals when impregnation is supposed to take place most frequently in the oviduct (Fallopian tube), and only occasionally in the ovary itself.

We now come to the pathological proof. By this is meant that if physiological qualities may be capable of transmission, disease may also be conveyed by the same route. Dr. Harvey believes that scrofula and phthisis may be transmitted in this way, but on account of the extreme prevalence of these diseases, and their transmission by ordinary inheritance, it would be difficult of proof. He considers, however, that in syphilis we have the necessary proofs.

He quotes Dr. Ramsbotham in the "Medical Gazette," 23d May, 1835. "It is a generally received opinion, I believe, that

syphilis in its secondary stage is not communicable directly to either sex from the other, that the disease is not propagated unless there exist an open chancre, and this accords with my observation. But it appears to me probable that if a previously healthy woman conceive of an ovum tainted by syphilitic virus derived from its father, her system may become inoculated during the progress of gestation, in consequence of the close vascular connection existing between it and herself, for it has fallen to my lot to see more than one case in which a young woman united to a man laboring under obstinate secondary symptoms remained healthy for some months after marriage, but became the subject of the same disease in its secondary form soon after impregnation had taken place, and I have considered that in such a case the mother derived the disease not directly from the father, but from the affected infant which she carried in her womb."

In 1837 Abraham Colles, of Dublin, announced to the profession a fact he had long noticed, but could not explain—viz., that when a mother acquires syphilis by blood contagion from the fœtus, she thereby gains an immunity, and does not suffer herself from any severe form of the disease; indeed, she may be without any obvious venereal symptoms. He further said he had never seen or heard of a single instance in which a syphilitic infant (although its mouth be ulcerated), suckled by its own mother, had produced ulceration of her breasts; whereas very few instances have occurred where a syphilitic infant had not infected a strange hired wet-nurse and who had been previously in good health. This shows most decidedly that the mother is protected from syphilitic infection. Jonathan Hutchinson has termed this "Colles' law."

Dr. Montgomery, of Dublin, in 1837 wrote, "Is it possible that a morbid taint—such as that of syphilis, for instance—having been once communicated to the system of the female, may long linger there, and, influencing several ova, continue to manifest itself in the offspring of subsequent conceptions when impregnation has been effected by a perfectly healthy man, and the system of the mother appearing to be at the time, and for a considerable period previously, quite free from the disease?" His reply is, "My belief is certainly in favor of the affirmative;" and, writing in 1856, he says, "Further experience and observation have, I think, shown to be fact what

I could then only venture to say I believed to be likely." Dr. Montgomery quotes the following case from M. Vidal: "A woman, whose husband was affected with constitutional syphilis, gave birth to a child, which in two months showed symptoms of that disease, of which it died. The woman never had any appearance of syphilitic affection, not even to soil her linen. Her husband died, and after remaining some time a widow, she married a healthy man, and about twenty months afterward (being four years after the former birth) she bore a child, which in two months presented the same form of syphilitic eruption which had appeared in the former child."

Dr. Montgomery has more to say on this subject. He says: "I wish to notice a fact the observation of which I thought was original with me, but I now find it was made long ago by others. It may be thus stated: A woman is married to a man who has latent constitutional syphilis by which she is infected, but will show no symptom of the contamination until she conceives and perhaps miscarries, and then the taint is manifested by the development of secondary symptoms in the course of a few weeks, as if the infection was at first communicated and confined to the product of the ovary, and the general system became thence contaminated. Or perhaps another explanation may equally apply, and we may suppose that the new condition and altered action of the generative apparatus had the power of rousing up and rendering active the latent poison lurking and dormant in the woman's system, as we see occasionally happen in patients constitutionally disposed to phthisis. Whichever of these explanations may be nearest the truth, there can be no doubt of the frequent occurrence of the fact."

M. Ricord says: "So long as a diseased father is under the influence of constitutional syphilis, the germ which is by him conveyed into the uterus carries along with it the syphilitic diathesis. . . . There is no such thing as an infection of the child by the mother, she having been contaminated by the father, but the husband procreates an infected child, which may then propagate the secondary poison to the mother—for where there are no children the mother does not suffer."

Dr. Carpenter says, anent the inoculation theory: "This idea is borne out by a great number of important facts, and it serves to explain the circumstance, well known to practi-

tioners, that secondary syphilis will often appear in a female during gestation, or after parturition, who has never had primary symptoms, whilst the father of the child shows no recent syphilitic disorder."

Dr. Tyler Smith says "that the most common mode in which women become affected with syphilitic uterine disorder is that in which the fœtus is the medium of communication;" and, further, he had observed in such cases that at each pregnancy a fresh dose of the syphilitic poison is imparted to the mother, unless in the mean time the husband has been the subject of antisyphilitic treatment.

Jonathan Hutchinson, in the "Medical Times and Gazette," 1856–57, published a paper on this subject, in which he gives a series of cases to show that a pregnant woman may become infected through a syphilitic fœtus—that is to say, without any primary chancre. This infection, he says, had been hitherto supposed to be due to the direct contagion of secondary syphilis. Further, that this form of syphilis is much milder than chancre syphilis; so mild, indeed, as to be without any evident symptoms other than the protection it affords to the mother when suckling her syphilitic child. He compares it to the milder form of small-pox which is communicated by inoculation, and the more serious disease when transmitted aerially. In 1876, in the same journal, he had another paper on the same subject. He corrobates Colles' law, and considers the protection due to a latent form of syphilis. As regards a woman who has given birth to a syphilitic child, but has never exhibited any symptoms herself, should she afterward get married to a husband quite free of syphilis and have children, the question as to whether these would exhibit syphilitic symptoms he confesses he cannot answer without more proof. In his more recent work on syphilis (1887), he says that it is obviously possible that the child would be syphilitic, but no facts have as yet proved it.

The most of the authors quoted are from Dr. Alexander Harvey's work, but they do not go the whole way to prove his theory. Dr. Ramsbotham speaks only of infection of the mother through the fœtus, and says nothing of subsequent children by a healthy husband. Colles' law goes no further. The same is to be said of the evidence of Ricord, Carpenter, and Tyler Smith. Jonathan Hutchinson considers it possible,

but not proven. The only complete evidence is that of Montgomery and the case he quotes from M. Vidal. Alfred Cooper, in his recent work on syphilis and pseudo-syphilis, seems to be in favor of Dr. Harvey's theory, but gives no reasons for his belief.

There is one most important authority who argues against this view. R. W. Taylor, of New York, does not believe that disease can be transmitted from the fœtus to the mother, and he quotes in his favor Kassowitz, Bärensprung, and Pick. He says that the disease may be transmitted from the mother to the ovum, and from the father to the ovum by fertilization, but not otherwise. He denies that syphilis can be conveyed through the utero-placental circulation, which, of course, means that it cannot pass either from the fœtus to the mother, or from the mother to the fœtus. Experiments, he says, have conclusively proved that the essential vehicles of the specific virus are cells or albuminoid molecules derived from an active syphilitic lesion, but after fecundation the embryo is not supplied with cells of any kind, but simply with serum. He believes that there are many cases of women who have given birth to syphilitic children, and yet they themselves remain free of syphilis, because the disease was acquired by the children direct from the father. He admits, however, that on this question he is in the minority, and that the opposite view is more generally believed in. As regards Colles' law, he says that the escape of the mother is due to some occult indiscernible change in her system.

It has always been admitted that there is a communication between mother and fœtus, or otherwise the nutrition of the fœtus could not be carried on. As to whether there is any return of material from fœtus to mother was not clearly made out, until the experiments of W. S. Savory were published in the "Lancet" in 1858. Previous to this, however, there had been some negative experiments of Majendie and Williams, of Liverpool; and Allison in his "Outlines of Physiology," founding upon these, said that it would seem that the transmission of fluids is almost entirely from the mother to the fœtus. The experiments of W. S. Savory were upon dogs and cats. The animals, of course, were pregnant, and under chloroform. The operation of Cæsarean section was performed, but the fœtuses, although removed from the uterus, and the

amnion punctured, were allowed to remain in connection with the mother through the umbilical cord. An injection was then made of a solution of strychnia into the thorax or abdomen of the fœtuses. Strychnia was selected because of its capability of ready absorption, and its obvious and unmistakable physiological action. In some cases the fœtuses were returned to the abdomen of the mother, and the abdominal wound closed with sutures. In other cases they were not returned to the abdomen, and the only maternal connection was through the umbilical cord. In these last cases there was not even contact with maternal tissues other than through the cord. In every case symptoms of strychnia poisoning developed in the mother. In these fœtuses which were not returned to the abdomen it was seen that the tetanic spasms appeared first, and in about fifteen minutes later tetanic spasms appeared in the mother.

These experiments of Savory, show undoubtedly that there is a return flow of material between fœtus and mother, and that through the umbilical cord and placenta. We do not, however, know its extent. Savory's experiments only indicate the limits of our knowledge at present. As regards other poisons, the probability is that their effect upon the mother through the fœtus would depend upon their solubility in blood serum. It cannot therefore be assumed, that because strychnia can pass in this way that syphilis can also pass. As far as our knowledge of syphilis extends at present, it certainly is not looked upon as a soluble poison. These experiments of Savory's, therefore, do not invalidate the position taken up by Taylor, of New York, when he says, that the embryo is not supplied with cells of any kind, but simply with serum; but Taylor, again, probably goes too far in making such a statement.

Darwin believes that the influence we are dealing with, acts directly upon the female genital organs. In favor of this view, we have the fact that among the *orchidaceæ*, the formation of the female cell is the result of pollination. Supposing, therefore, that all the other cases could be accounted for in this way, the analogy from syphilis would fail. Because in that case, we would expect that syphilis would, instead of inoculating the ovum with syphilis by fertilization and thence the mother, act directly upon the maternal genital organs. But this is a mode of transmission which is denied by every

modern authority on syphilis. Fournier says, that experiment has recently and clinical observation long established, that the serum of a syphilitic subject is not capable of transmitting contagion.

On the other hand, accepting Dr. Harvey's view that the influence acts in every case through the embryo, the analogy is complete; in plants acting upon the embryo and extending from thence to the seed coats and the ovarium; and in higher life, extending perhaps to the whole maternal organism, on account of the permanent ovarium and the lengthened connection between fœtus and mother (here comparable to a case of graft-hybridism), transmitting both physiological and pathological qualities.

That the male element has an influence upon the female, over and above its fertilizing influence upon the ovum must be conceded. The limits of that influence are at present unknown. The wide range suggested by Dr. Harvey is by no means proven, but is quite probable; the evidence does not entitle us to go beyond this.

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[1] Read before the Glasgow Southern Medical Society, March 8th, 1888.

THE INTERNAL AND EXTERNAL

Temperature of the Human Body

AS

MODIFIED BY MUSCLE-KNEADING:

WITH

SPHYGMOGRAPHIC AND SPHYGMOMANOMETRIC RECORDS.

BY

A. SYMONS ECCLES, M.B.

10—2

THE INTERNAL AND EXTERNAL

TEMPERATURE OF THE HUMAN BODY

AS MODIFIED BY MUSCLE-KNEADING.[1]

THE observations on the internal and external temperature of the human body which I have ventured to offer for the consideration of this section are based upon a series of experiments extending over a period of nearly eighteen months, but the examples selected for their illustration are derived for the most part from the records obtained during the past five months, before and after subjecting healthy individuals to the process of kneading the muscles of the trunk and limbs on the one hand and the abdomen with its contents on the other. The results afforded by these examples are identical with those which were noted in the earlier experiments, differing from them only in their elaboration by the addition of sphygmographic and sphygmomanometric readings taken under the same circumstances as the thermometric records.

In order to avoid as far as possible any sources of error in the investigations referred to, the individuals dealt with were carefully examined as to the state of their organs, secretions, habits, and mode of life; and any conditions which might tend to modify the uniformity of the circumstances under which the observations were made have been noted. Briefly, the subjects were all healthy persons who had not taken food for four hours prior to the hour appointed for experiments, which were carried out in a room whose temperature, as registered by an ordinary thermometer placed at the head of the couch, was maintained at 65° F. The subjects were divested of their

clothing and placed in the recumbent position on a couch or bench, and covered with a Turkey towel sheet and a warm rug. The thermometers were then applied in the situations indicated—an ordinary magnified index clinical thermometer for the axilla, three Immisch's for the surface, and a strong clinical thermometer of the ordinary pattern for the rectum (this last being encased in metal to avoid any untoward accident). As soon as the thermometers had been adjusted, sphygmographic tracings and sphygmomanometric readings were taken of the radial artery on the right side, the pulse being also taken by the finger. In every case Richardson's modification of Dudgeon's pocket syphygmograph was employed, the clockwork being wound up before each application, and the length of the band necessary to inclose the wrist and retain the instrument firmly in position having been ascertained, a distinguishing mark was made on the ends of the band exactly where the clamp was first secured, so that it might be adjusted accurately in the same position on each subsequent occasion of its use for the same individual. The same pressure was always used for all the tracings taken from the artery of a given individual throughout the experiments to which he was subjected, but varying pressures were employed in different individuals. In regard to the manometric records, they were taken with von Basch's pocket sphygmomanometer, care being taken to avoid any error through slow leakage by refilling the tube whenever the drum (or "pelotte") appeared to contain any air; and in each case the compression of the artery was repeated, the reading recorded by the pointer being taken at the moment of perceptible disappearance and again of first perceptible reappearance of pulsation.

The conditions of temperature and circulation having been thus noted, kneading of the lower extremities, trunk (excluding the abdomen), and upper extremities, in the order here set down, was employed for a period varying from half to three-quarters of an hour, according to the time required in order to thoroughly carry out the manipulations, necessarily varying with the muscular development of the individual; but in each case the character and extent of the kneading were rendered as uniform as possible.

At the conclusion of the muscle-kneading the instruments

were reapplied, and, the readings having been taken, abdominal massage was then employed, the stomach and liver being first dealt with, then the small intestines, and finally the colon and sigmoid flexure, the course of the large intestine being carefully followed, its gaseous or solid contents being propelled as far as possible toward the commencement of the sigmoid flexure. Abdominal kneading, as a rule, occupied from fifteen to twenty minutes, but occasionally, as in the case of Example H, the process was prolonged.

The records were again taken, and the experiment thus concluded, save in the cases of certain individuals who submitted themselves to further thermometric investigation with a view to show the length of time during which the effect of the manipulations appeared to be maintained.

The first example to which I desire to draw your attention may be taken as typical of a series in which the effects on the circulation described by me in a paper on the physiological effects of massage, read before the Royal Medical and Chirurgical Society of London in January, 1887, are produced, and further investigated and confirmed by the sphygmographic and sphygmomanometric records. So, also, with the thermometer, previous observations have received confirmation, but an additional inquiry into the internal temperature as indicated by rectal thermometry has been included in the experiments made, with the unvarying result shown in the tables of temperature that as the axillary and surface temperatures rise under the influence of muscle-kneading the rectal temperature falls, while exactly the opposite effect is produced by kneading the abdomen. The subject of this experiment was a healthy male, aged 25, whose height was 5 feet 8 inches and weight 10 stone 12 pounds, with good muscular development, free from organic disease of any kind, and leading an active life.

TABLE OF EXTERNAL AND INTERNAL TEMPERATURES IN EXAMPLE H.

Before Muscle-Kneading.	After Muscle-Kneading.	After Abdominal Kneading for 15 mins.	20 mins.	30 mins.	Situation of Thermometer.
98.0° F.	99.4°	98.8°	98.0°	97.4°	Axilla.
90.0	97.0	93.0	89.0	84.0	Palm.
91.0	95.0	93.0	90.0	88.0	Calf
87.0	90.0	87.0	84.0	81.0	Sole.
100.4	99.6	99.8	100.6	101.8	Rectum

It will be noticed in this example that the initial axillary temperature is only 98° F., somewhat lower than that which is indicated on the scale of clinical thermometers as representing the average normal; but I attribute this to the unclothing of the patient, rather than to any inaccuracy in the record, as the thermometers for each reading were kept *in situ* for ten minutes, so as to avoid any error arising out of hurry in taking the note. The surface temperatures having in each case been taken by means of an Immisch thermometer, fractions of a degree are not noted. The effects of muscle-kneading are well seen in this example in regard to the internal and external temperatures; for whereas there is a difference of 2.4° F. between the axillary and rectal temperature, as much as 13.4° F. between the temperature of the foot-sole and the rectum, 9° and 10° respectively between the calf and palmar temperature and that of the rectum, and a corresponding difference between the axillary and surface temperature, it is found, on reference to the next column, that the axillary temperature has been raised 1.4° F., the surface records more nearly approach the axillary degree, while the rectal temperature shows a declination of 0.8° or $\frac{1}{5}$°.

After abdominal kneading only, practised on the same occasion as soon as the temperature and pulse records had been made after muscle-kneading, one finds a gradual decrease in the axillary and superficial temperature, with a steady rise of rectal temperature, until at the close of half an hour's abdominal manipulation (excluding the necessary intervals for the observations recorded at the close of fifteen and twenty minutes), the axillary temperature stands at 97.4° F., a decrease of 2° F. below the post muscle-kneading record, with a much more marked reduction of surface temperature, and a gain in the rectum of 2.2° F. above the degree noted before abdominal kneading, and of 1.2° F. above that which was registered by the rectal thermometer before the muscle-kneading had been carried out. It will, I think, be interesting to compare with these alternations of temperature the condition of the circulation so far as observations on the radial pulse will allow.

First, in regard to the pulse rate, it was found to vary as follows:

Before Muscle-Kneading, ... 78

After Muscle-Kneading, ...	70
After Abdominal Kneading for 15 mins.,	72
" " " " 20 "	66
" " " " 30 "	64

The sphygmomanometric readings were:

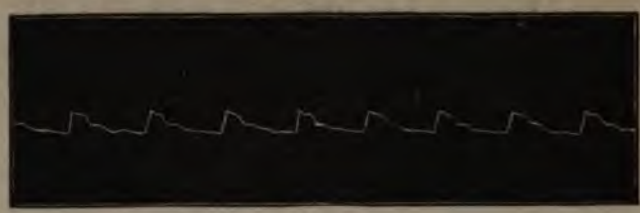
Before Muscle-Kneading, ...	130	mm. Hg.
After " " . . .	170	"
After Abdominal Kneading for 15 mins.,	140	"
" " " " 20 "	120	"
" " " " 30 "	120	"

The sphygmographic tracings were taken under a pressure of three ounces, the precautions previously referred to having been taken to insure accuracy.

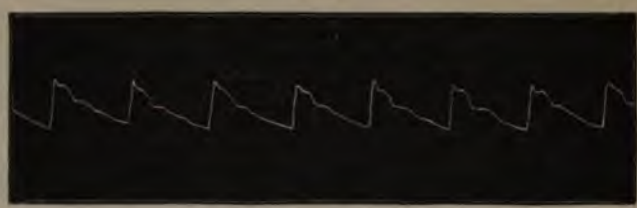
I will not here attempt to analyze the characters of these readings, except in reference to those which appear to be common to all the experiments, for it will be found that, although one sometimes notes a diminution in the pulse rate after general kneading, excluding the abdomen, occasionally, especially if the kneading is not prolonged, the pulse rate is rather accelerated than diminished, and this (which has occurred more frequently in my practice since the conclusion of the experiments, of which my previous paper on the physiological effects of massage was the record, than before) I attribute to a modification of the reflex action following stimulation of the cutaneous and muscle sensory nerves, which I believe depends not only on the vigor or intensity of the stimulus applied, but also in a great measure on the varying irritability of the general nervous system to which the irritability of the cutaneous sensory nerves is a valuable index. But in regard to the modifying influence of abdominal kneading on the pulse rate it will always be found, so far as my experience hitherto goes to show, that this is in the direction of retardation, even in cases of what, for want of a more clearly recognized condition, are termed abdominal neuroses, in which the pulse rate is already diminished.

It will be seen on reference to the temperature records, tracings, and manometric readings, which I have brought with me to-day for your inspection, in addition to the examples quoted in this paper, that the records just referred to are by no means the most remarkable, as some of the others afford

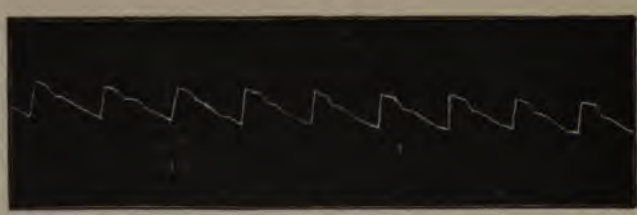
SPHYGMOGRAPHIC TRACINGS IN EXAMPLE H. PRESSURE 3 OUNCES.



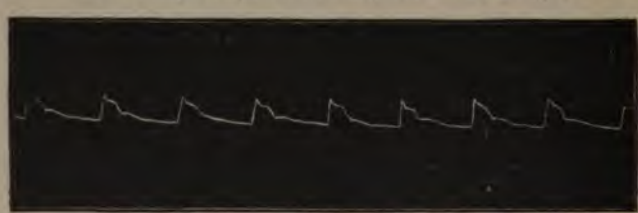
Before.



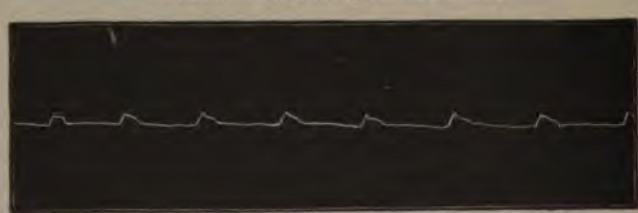
After.



After temperature records before abdominal kneading.



After abdominal kneading, fifteen minutes.



After abdominal kneading, twenty minutes.

After abdominal kneading, half an hour.

better examples of the pulse-rate variations; but I have selected this experiment rather with a view to demonstrate the effect of abdominal kneading as compared with muscle-kneading on the temperature topography than on the pulse.

Now allow me to refer to an example in which, while the majority of effects produced by the different manipulations are similar to those occurring in Example H, it will be seen that here muscle-kneading was followed by acceleration of the pulse rate, other effects undergoing no apparent variation from those noted with a diminished pulse rate.

TABLE OF EXTERNAL AND INTERNAL TEMPERATURES IN EXAMPLE B.

Before Muscle-Kneading.	After Muscle-Kneading.	After Abdominal Kneading.	Situation of Thermometer.
98.4° F.	99.8°	98.6°	Axilla.
94.0	97.0	96.0	Palm.
95.0	97.0	94.0	Calf.
93.0	95.0	92.0	Sole.
99.0	99.0	100.4	Rectum.

The maintenance of the rectal temperature after muscle-kneading alone constitutes the only deviation from the usual condition, and does not occur in the other cases wherein the effects have been noted in dealing with healthy persons under ordinary conditions of activity; but it is not so infrequent in cases of persons whose surface temperature appears to be improved by a course of massage pursued during a period in which the patient is kept at rest in bed.

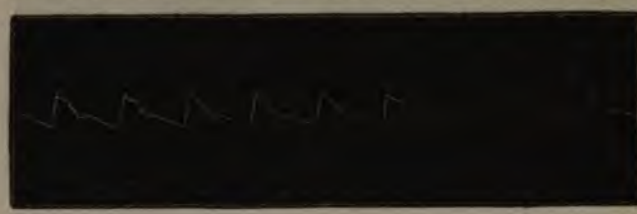
In this case the pulse rate varied as follows:

Before Muscle-Kneading, ... 84
After " " 102
After Abdominal-Kneading, ... 60

The sphygmomanometric readings were:

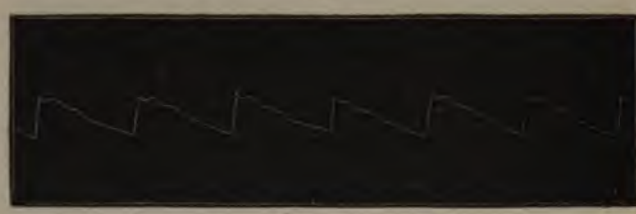
Before Muscle-Kneading,	. .	140 mm. Hg.
After " "	. . .	160 "
After Abdominal Kneading,	. .	140 "

SPHYGMOGRAPHIC TRACINGS IN EXAMPLE B. PRESSURE 2½ OUNCES.



Before.

After.



After abdominal kneading.

Under a pressure of two ounces and a half the sphygmographic tracings show an increase of amplitude of the ascending limb with a more rapid fall after muscle-kneading, the amplitude of the trace, even after abdominal kneading, being in excess of the first tracing taken before any manipulations had been practised, while the retardation of the pulse after the abdominal kneading amounts to 42 beats per minute. The subject was a man, aged 40, of somewhat spare habit of body, who appeared to be free from disease; but he was a little inclined to be afraid of the instruments on this occasion, the

first of several experiments to which he subsequently submitted without alarm.

It appears, therefore, that the effect produced on the rate of the circulation by muscle-kneading varies from not a very marked reduction of rapidity in the majority of cases to an increase in celerity sometimes amounting to twenty beats or more in a comparatively few cases; but clinical experience teaches that the effect on rate alone is not a reliable guide as to whether or not treatment by mechano-therapy is likely to prove valuable; the effects on temperature, however, are very significant, and have been found useful by me in helping to decide as to what dosage of the various manipulations should be employed in different cases. Moreover, it is found that under a course of muscle-kneading extending from three weeks to two months, the temperature topography, which in feeble persons, and notably in dyspeptics and persons suffering from malassimilation, assumes much greater disproportions as between axillary, surface, and rectal temperatures than in health, will be modified very considerably, internal and external temperatures being more nearly approximated and less easily influenced than before the treatment, which of course consists also in careful dieting and rest.

If I have transgressed in referring to these clinical matters before this Section, I have done so because the question may arise in regard to these observations, *Cui bono?* To those who do not regard this method of treating disease by mechanical rather than pharmaceutical means as a fad unworthy of serious investigation, it may possibly impart an interest to these observations on healthy persons undertaken in order to test certain phenomena previously noticed at the bedside, and I would venture to hope that these records, imperfect though they be, may induce some who are inclined to deny the efficacy of mechano-therapy to see whether the failures they have met with are not rather due to its unskilful application by persons who, if they knew how to perform the ordinary manipulations, are not to be intrusted with the administration of the remedy save under the most rigid supervision of one who is conversant with the subject.

It will be seen from the temperature records before you that the immediate effects of muscle-kneading are to raise the external temperature, and at the same time to approximate

the external and internal temperatures, the rectum apparently losing heat while the surface of the body gains it, and in some instances the axillary temperature has been found to be higher by a fraction of a degree after muscle-kneading than the rectal temperature; this may be an error in the thermometry, but as it has occurred with different thermometers and on various occasions, I have thought that possibly it may be accounted for by an actual loss of heat in the abdominal organs owing to the abstraction of blood from them toward the periphery, where not only are the vessels dilated and the blood current increased in volume, but, as I think we may infer, greater activity of interchange between the blood and the tissues has been brought about by the mechanical stimulation of the local nerves. The increased blood-pressure following muscle-kneading is followed by a marked fall on the substitution of abdominal kneading; it would therefore appear that, as abdominal kneading causes a diminution in the volume of the radial pulse, previously enhanced by muscle-kneading, we should not be guilty of unfair theorizing if we believe that the loss of rectal heat is due to a diminution in the calibre and contents of the abdominal vessels with a synchronous cooling of the internal temperature, and this is the obvious conclusion to be arrived at if, on the other hand, the rise in rectal temperature is to be attributed to the altered conditions of abdominal circulation, which it is probable exist in a modified degree, as Goltz proved them to occur in his tapping experiment on the frog. Certainly the characters of the peripheral circulation, as shown by the sphygmomanometer and the sphygmograph, are somewhat akin to those which have been noted when, as it is said, "the animal was as it were bled into its own belly."

The gain in surface-temperature following the muscle-kneading will be lost by radiation if the subject is not kept well covered both during and after manipulation; and it may not be uninteresting to note here that where these precautions are omitted the whole body temperature will be reduced if the surface, with its greatly-dilated vessels, is not protected from the effects of exposure. I have known the axillary temperature, after having been raised to 99.8° F., fall to barely 97° F., and the rectal temperature to below 98° F., the thermometers having both been shaken down to 95° F. before being placed

in position. Now this loss of heat does not follow either the one form of kneading or the other if the surface of the body is kept covered. The immediate effects of the process do not maintain their intensity for a longer period than an hour, so far as my observations serve; but for three hours after a noticeable effect exists, in that the temperature will remain more nearly equalized, and the amplitude of the pulse-tracing remains increased above the record taken prior to the muscle-kneading for over two hours after the conclusion of the experiment.

The effect of manipulating the muscles on the circulation, as shown by the sphygmograph, is invariably that the amplitude of the ascending portion of the trace is increased, and with this it is also rendered more vertical; dicrotism as a rule appears to be less marked, and sometimes a systolic plateau is developed to a greater extent than it was prior to the kneading; but with the exception of the increase in amplitude and verticality, there is no constant feature common to all the tracings taken. This greater amplitude and verticality of the systolic wave must, I suppose, denote a more sudden and forcible contraction of the ventricle, though, as some of the traces show, this does not always imply a short, sharp systole, for in certain of the subjects the contraction appeared to be prolonged, a long vertical upstroke being followed by an almost horizontal short line terminating in a more or less well-defined notch.

Burdon Sanderson has attributed the sharp expansion of the artery to reflex influences on the heart, and has described what he calls "the shock sound" heard at the impulse preceding or inaugurating the first sound of the heart; this sharp sound I have only been able to recognize in the cases where the pulse rate was reduced after muscle-kneading in patients suffering from chronic Bright's disease or gouty symptoms with arcus senilis and other signs of arterial degeneration, and in one case after a month's kneading the sound appeared to be less easily distinguishable. The greater verticality and amplitude of the wave in the tracings appears to be associated with an increased quantity of blood sent through the vessel, which is obviously dilated; it may be that on the conclusion of the kneading the vessels of the limbs are almost over full, and thus give rise to the sudden and more forcible contraction

of the heart, in order to send the blood through the distended vessels; the manometric records point to a greater fulness of the vessel, and this also is usually apparent to the finger. The conclusions I have ventured to arrive at from the results obtained by these experiments and clinical observations are that after general kneading, excluding the abdomen, the amount of blood sent out by each systole is increased, the quantity of blood sent to the right side of the heart being increased by the centripetal squeezing of the veins, the circulation through these vessels being by this process aided and accelerated, thus providing a greater volume of blood for distribution by the pulmonary system, and so supplying a larger quantity of blood to the left side of the heart, the increased pressure so produced within the ventricle stimulating it to more forcible contractions. The force of the cardiac systole, I believe, is increased, whether the pulse rate is accelerated or retarded by muscle-kneading, the influence on rhythm being of a reflex character, depending on the degree of stimulation of the sensory nerves, the slighter stimuli afforded by moderate kneading[2] affecting the accelerator centre, which we are told that "it is more than probable exists in the medulla oblongata,"[3] while the stronger stimulation of vigorous kneading affects the vagus centre.

My reasons for believing that the increase in pressure recorded by the manometer after muscle-kneading depends on the action of the heart equally in the cases of accelerated and retarded pulse rate, rather than on the condition of the peripheral vessels, are based on the fact that the manometric pressure was estimated at the moment when the pulse ceased to be felt by the testing finger on the distal side of the drum or "pelotte." I am aware that, unless the greatest care is taken to avoid too long compression of the vessel, an erroneous reading will result, as one will obtain a record of the centripetal *plus* the centrifugal wave, if practice has not rendered the tactile sense more keen than it is at first when commencing to employ von Basch's little instrument; and, unless I had been warned against this source of error, and had been careful to obviate mistakes arising out of it, I should not have ventured to draw your attention to this phenomenon of apparent independence between pulse rate and pressure, or rather, as I would prefer to state it, with great diffidence, as the result of

these observations, the apparent independence of the force of the ventricular contractions on their number.

Marey has shown that the effect of muscular action, as tested by his experiment on the horse, in which he applied his compensating manometer to the carotid before and after making the animal canter for ten minutes, is to increase the frequency of the pulse and to decrease arterial tension, exactly opposite conditions arising after the animal had been allowed to rest; from which he argues that the first effect of muscular exercise is to accelerate the course of the blood in the vessels of the limbs, the acceleration of the heart's rhythm being a secondary effect, and depending on the decrease of arterial tension which follows on the dilatation of the peripheral vessels. Within the limits of this paper it is not possible to detail further the deductions drawn by so great an authority on this subject, but he sums up his views thus:

"So, then, one of two conditions exists; either the force of the heart is first increased, and under some exciting influence the beats of the heart are accelerated; or the first effect is a more easy flow of blood through the small vessels, from which arises lowering of arterial tension and secondary acceleration of the heart. One way of settling the question is to gauge the arterial tension by means of a manometer. In fact, in the first case, if it is an excess of impulsion which constitutes the initial phenomenon, there ought to follow an elevation of arterial tension. In the second case, the tension will be diminished. The enormous increase of energy in the heart's beat under these circumstances would tend to make us believe that the heart really expended greater force after violent muscular exercise. It is not so. The fall of arterial tension increases the force of the pulsations of the heart and arteries."[4]

It was a source of great perplexity to me when I found, both under the circumstances of increased and decreased rapidity of pulse after muscular kneading, that, with what one believes to be a condition of dilated vessels as shown by the greater warmth and redness of the surface, and the visibly greater fulness of superficial vessels, one also obtained from von Basch's sphygmomanometer a rise of pressure; and if careful search for a source of error and constant repetition had not confirmed the result of the earlier experiments, I should have felt still greater hesitation than that which I feel

to-day in drawing your attention to this unexpected and unlooked for condition, which is apparently the result of kneading the muscles of the limbs and trunk.

I much regret that I have not been able to institute control experiments with a schema which doubtless would have helped to clear up this difficulty; but, failing this, the fact remains that unless some fatal inaccuracy has crept into the observations made, the sphygomomanometric pressure is increased independently of the increase or decrease in the number of the heart's beats, and in spite of the dilatation of the vessels; so that, in default of a better explanation of this phenomenon, one ventures to suggest that the effects of muscle-kneading, as shown by thermometric, sphygmographic, and manometric readings, is to increase the force of the heart's action, the quantity of blood passing through the external organs (muscles and skin), and the interchange between these tissues and the nutritive fluids, whose passage through them is thus facilitated.

On the other hand, judging from the results obtained by similar tests in their application to the effects produced by abdominal kneading, one believes that by this process the rhythm of the heart is influenced uniformly in the direction of retardation, the vessels of the external tissues, probably also of the brain,[5] are contracted and unloaded, the circulation through these parts, as also their warmth, being diminished; while, judging from the increase of rectal temperature arising during and after the process, it is probable that the abdominal organs undergo a modification of their circulatory conditions similar to that shown to exist in the skeletal tissues after muscle-kneading.

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THE

DISEASES OF THE BREAST.

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WITH 13 ENGRAVINGS AND 4 CHROMO-LITHOGRAPHS.

10—3

DISEASES OF THE BREAST.

CHAPTER I.

THE object of this work is to place before the student and practitioner a clinical exposition of the abnormalities and diseases of the breast, more particularly with reference to their diagnosis and treatment. With this view the descriptions of pathological processes have not been placed in the foremost position, and it has been assumed that readers of this volume are familiar with the leading *macro*scopical as well as *micro*scopical features of the different varieties of tumors, such as are to be found described in the many excellent works on pathological anatomy.

The pathological aspects of disease have, however, been referred to, to elucidate its clinical phases, and more particularly to show how the signs and symptoms of local disease are to be explained by progressive pathological processes.

To render the clinical aspects of disease clear, brief notes of cases have been quoted, to illustrate either a subject or a symptom; and with a like object colored plates have been freely introduced, many of which have been copied from the originals in Guy's Hospital Museum.

In preparing this work I have to thank Dr. J. Goodhart for his kind aid in revising the pathological portion, and Mr. C. Symonds for some valued microscopical investigations.

ANATOMY OF THE BREAST.

It is essential that the practitioner when examining a diseased breast should always have in his mind's eye the anatomy of the healthy organ. He should remember that the

breast is a skin gland situated in the connective tissue between the layers of the superficial fascia; that the gland itself is encapsuled, with its posterior wall slightly concave, resting and moving upon the pectoral muscle, and the anterior wall convex, separated from the skin by more or less lobulated fat, and at the same time connected with it, in suspended form, by fibrous bands, which are known as the suspensory ligaments of the breast (Plate I., Fig. 1).

The boundaries of the gland are not, however, always very exact, and it is not uncommon, as demonstrated by disease, to find processes, or rather lobes, of the gland projecting into parts which seem to be outside the radius of the normal gland. The frequency of this extension from its axillary border is so great, that it may be open to a question whether it may not be regarded as a normal condition. In operations upon the breast this anatomical condition is worthy of remembrance.

In thin people there is but little fat between the gland and the skin covering it, and under such circumstances there is an absence of that roundness and plumpness which so characterizes the breast of a healthy and well-made woman.

On the other hand, in fat women, even when the gland itself from senile atrophic changes has shrunk to very small dimensions, the deposit of fat around the gland being large, maintains the shape and size of the breast.

The presence or absence of fat about the gland has consequently an important bearing in modifying the manipular indications of a healthy as well as of a diseased breast. A small tumor in a thin breast is readily recognized, whereas in a fat one it might be overlooked; and a scirrhous infiltration of an atrophic breast of a fat woman might suggest the presence of a large tumor, when in reality the bulk of the growth is fatty tissue.

The practical bearing of the existence of the suspensory ligaments of the breast is very great, since it is by the shortening of these ligaments that the characteristic "dimpling" and "puckering" of the skin, so frequently seen in the infiltrating form of cancer of the breast, is brought about.

The gland itself is a conglomerate, racemose, or compound organ, made up of from fifteen to twenty distinct lobes, subdivided into lobules; the lobules on section presenting a pale pinkish cream-colored appearance. Each lobe is held together

by firm fibrous tissue, and yet at times is separated by fat; each lobule is surrounded by connective tissue for a support, as are likewise the smaller lobules and secreting acini of the gland.

This connective tissue may become the seat of connective-tissue neoplasms (sarcomata); the acini and ducts the seat of adenomata and epithelial (cancerous) neoplasms.

Connected with each lobe there is an excretory galactophorous or lactiferous duct, which terminates in the nipple, and during lactation this tube as it approaches the nipple becomes dilated into a sinus or ampulla, one-quarter or one-sixth of an inch wide, and these ampullæ act as reservoirs for the milk when secreted. Each terminal tube opens in the nipple by a separate orifice, which is smaller than the tube, while the small initial tubes or ducts of the acini and lobules unite together, and so help to form the larger tubes as they converge toward the nipple.

The lobes, lobules, and acini of the gland are lined by an almost structureless basement membrane covered with epithelium, and this epithelium varies in character according to its position and to the condition of activity of the glands. In the lactiferous ducts, from the reservoirs to their terminations, the epithelium appears as small oval corpuscles with a central nucleus to each; toward the orifices of the ducts the epithelium tends toward a squamous appearance. In the reservoirs the epithelium is of the tesselated form; columnar cells are said also to be present by Kölliker and Birkett. When the breast is in an inactive condition the epithelial cells are small and granular, but when physiological activity begins, the alevoli enlarge, and become filled with a clear secretion. The cells appear flattened out against the membrana propria, or basement membrane, and contain fat globules of varying sizes. When the gland is in full activity the epithelial cells become cubical, or even columnar, but are irregular in size, and exhibit indications of segmentation, and discharge into the cavity of the alveoli.

"The secretion of the breasts is formed by the bursting of these cells, and the discharge of their contents into the alveolus, the fat globules which were present within the cells becoming suspended in the fluids of the alveoli as milk globules, and the albuminous constituents of the cells becoming dis-

solved and forming the casein and other proteid substances of the milk."[1]

"The mature functions of the breast," writes Creighton, "are in effect a sustained repetition of those cellular changes which the embryonic cells went through in order to become the breast," and no doubt the spurious or morbid pathological evolution and involution of the gland is marked by changes in its epithelial or secreting structure, which in a measure or to a degree simulates these changes.

In intermediate stages between these two extreme physiological conditions, as well as when the gland is in a morbidly active state, changes in the epithelial lining of the acini will be visible, analogous to those which take place in the gland in its physiological evolution and involution.

The blood-vessels of the gland, which are numerous, invest the alveoli, but do not come into direct contact with the secreting cells themselves. In the breast, as in other secreting glands, the vessels lie outside the basement membrane upon which the epithelium is placed, and according to Schäfer are separated from the secreting cells by the lymphatics. Hence, the material for the nutrition of the cells is not drawn from the blood direct, but from the lymph of the breast gland.

The arteries of the breast are thoracic branches of the axillary, branches from the aortic intercostals, and the intercostal branches of the internal mammary. There is a markedly free anastomosis of veins, more particularly around the areola.[2]

The lymphatics from the breast are also numerous; they are superficial and deep, and pass in two main lines. Those from the axillary and lower half of the gland run to the axilla; whilst from the sternal half they pass to the glands situated along the course of the internal mammary arteries beneath the sternum. Lymphatics from the upper part of the gland pass into the cervical region, and not necessarily through the axilla.

The nipple (mammilla) occupies a position slightly below the centre of the gland, on a level with the lower border of the fourth rib; its projects in the virgin state forward, outward, and slightly upward; during the progress of a pregnancy it turns downward. The surface of the nipple is dark, and around it is an areola, which in the virgin is of a light

rosy pink color, and in the prolific matron becomes dark; the darkness of the areola commencing at the second month and increasing with every month of pregnancy. As the gland returns after lactation to its quiescent condition the darkness of the areola may diminish, but does not disappear.

The skin of the areola is wrinkled and covered with roundish elevations, which are sebaceous follicles known as large and small areola glands; every gland opens by four or five ducts on each papilla. When the ducts are obstructed a sebaceous tumor may form. The nipple contains some muscular tissue, and the terminations of the fifteen or twenty excretory gland ducts. The central ducts are the larger; and outside the ducts, in the areolar tissue which surrounds them, the blood-vessels ramify. The ducts become narrow at their orifices, and open in the little depressions seen in the apex of the nipple.

The skin covering the mammary glands receives its sensibility from the anterior and middle branches of the second, third, fourth, and fifth intercostal nerves, whilst the skin over the upper border of the gland is supplied by the supraclavicular branches of the cervical plexus. These points should ever be remembered, for pain may follow the course of these nerves and be experienced over the region of the breast which they supply, without the existence of any breast disease.

The mammary glands are the same at birth in both sexes. The development of the gland takes place in the female at puberty, at or before the first catamenial period. From puberty to the cessation of the catamenia the glands are in the condition of dormant developmental perfection, but this stage itself is reached only when from pregnancy the full physiological functions of the glands are called into activity.

After the cessation of the catamenia, when the functional activity of the glands can no longer be called into requisition, a period of functional decline commences, which in the healthy subject ends in a simple atrophy of the secreting acini of the glands.

At each of these periods certain troubles are prone to appear, to which attention will be drawn in the following chapters.

CHAPTER II.

ABNORMAL CONDITIONS OF THE BREAST AND NIPPLES.

THE abnormalities of the breast and nipple show themselves either in the way of excess or of deficiency. Those of excess are the more common, and strange as it may seem, they are more frequent in the male than in the female sex. Dr. Mitchell Bruce, to whom we are indebted for an able paper on this subject,[8] tells us that out of nearly four thousand men and women examined consecutively, sixty-one had supernumerary nipples, forty-seven were males and fourteen females. In a second series of cases, examined exclusively for the purpose, about seven out of every hundred consecutive individuals had the deformity, and it was found nearly twice as often in men as in women. Five out of six of Bruce's cases had but one supernumerary breast or nipple, whilst the sixth had more than one. Most of the instances observed have been situated on the front of the trunk, below the level of the ordinary mamma, and somewhat nearer the median line of the body than the normal gland. These supernumerary parts were distributed, as ingeniously pointed out by Bland Sutton, in the course of the internal mammary and deep epigastric vessels. In exceptional instances these excesses have been found in extraordinary positions. Again, these supernumerary parts are more frequently found on the left than the right side of the body, in the proportion of sixty to forty per cent. The figures of Bruce, Leichtenstern, and others, clearly indicate this fact.

Leichtenstern, in discussing the cause of this curious disproportion, maintains that the left mamma is on an average more developed than the right, and mentions Hyrtl's explanation of this inequality, that it is so because mothers use the left gland more in suckling. He, however, himself maintains that the same condition holds good in the child and virgin,

which, if a fact, adds Bruce, is probably an instance of variety "as the inherited effect of use,"[4] and a point of extreme importance in the question of the significance or origin of supernumerary mammæ. "We may doubt also," wrote Darwin, "if additional mammæ would ever have been developed in both sexes of mankind, had not his early progenitors been provided with more than a single pair."

The supernumerary nipple is commonly placed about three inches from the normal nipple. In exceptional cases it may be only about one inch distant, while in others it may vary from three to six inches. But whatever may be the distances in childhood, Bruce has satisfied himself that the distance may increase considerably with age.

The characters of the supernumerary gland or nipple vary exceedingly. "Some examples," writes Bruce, "might be chosen for description, which in every particular, except size, resemble an ordinary male mammilla, while others require considerable experience for their discovery and identification. The best-marked cases present the central papilla or nipple proper, a pigmented areola, follicles, hair, and a distinct depression on the apex of the papilla. Examples such as these are, however, very rare. The more usual condition is the presence of a small papilla, or elevation more or less like the ordinary male mammilla, "or a low ovoidal prominence, with its long diameter in the transverse direction, slightly inclined downward and outward, and having its summit usually distinctly cleft into two lobes by an opening or deep groove parallel with the diameter, this variety somewhat resembling the retracted nipple of some female breasts."

The papilla of the supernumerary mammilla may frequently be found erectile.

The areola of a supernumerary nipple may be entirely absent, or it may be represented by the smallest line of pigmentation around the base of the papilla. In some cases it exists as an areola of natural dimensions and appearances; in others it is pigmented in variable degrees, whilst in some examples all pigment is absent.

Follicles and hairs are not commonly present in the supernumerary nipples. In exceptional examples, however, some strong pale or black hairs are met with.

Supernumerary nipples found above the normal mammilla

are very rare. Bruce says only four cases of the abnormality are on record, and in all of these four the supernumerary was placed outward as well as upward from the normal organ. Dr. Fitzgibbon has recorded an example of this kind, in a soldier, aged twenty-four, a native of Jamaica, who not only had two supplementary nipples, one on each breast about one inch below the normal nipple, but two pigmentary deposits, one on either breast higher up above the ordinary mammillæ, which were clearly supernumerary nipples. When the man was young the lower supplementary were larger than the natural nipples. When seen by Dr. Fitzgibbon they were smaller. Among the cases of supernumerary breast which have been recorded, three are four or five in which five mammary glands existed; one of these has been minutely described by M. Gorré, as reported by Percy. Four of the glands in M. Gorré's case were very projecting, full of milk, and arranged in two lines; the fifth breast was not larger than the breast of a girl before puberty, and was placed below and in the middle of the body, between the interior pair, and five inches above the umbilicus.

Cases in which four breasts have been seen are recorded by Sir A. Cooper, Dr. Robert Lee, and Dr. Shannon; others in which three breasts existed, by Dreger, Bartolin, G. Hannæus, J. Borel, Robert, and Sneddon. Where these abnormalities exist others are not unfrequently associated with them. Thus, in a girl, aged six, whom I saw in September, 1883, with a supernumerary nipple and areola one inch below the left nipple, there was some malformation of the genital organs; apparently no vagina, and a clitoris as large as a boy's penis, with prepuce and orifice as of a urethra, which passed down the clitoris for half an inch; the urethra was normal.

Percy states that Anne Boleyn, who had six fingers and six toes, had three breasts.

Supernumerary glands are sometimes active; and as a rule it has been from their functional activity during pregnancy or lactation that their presence has been made known. Dr. Bruce had not, however, seen an example of this kind, and in not a single instance would the subject of the abnormality confess to any alteration of the parts in pregnancy or during menstruation.

On April 6th, 1831, Mr. Roberts, an able practitioner, exhibited before a London Society (the Hunterian) the model of a female breast with two nipples. They were a quarter of an inch apart, and the woman was able to suckle by either. It is said, indeed, that in most of the examples recorded when the breast is lateral, the supernumerary nipple emitted milk, but when it is median, this is not always the case. In an instance which has passed under my observation, this was not, however, the condition; the case was as follows: Supernumerary nipple and breast. Sarah P., aged forty, the mother of eight children, all of which she had suckled, came under my care on September 25th, 1862, with a supernumerary nipple about two inches below her right breast. The nipple looked quite like the ordinary nipple, but never discharged milk. It did not appear to have any connection with the right breast, but the parts beneath it were full, and this suggested the presence of a supernumerary gland. The fact, however, that during her eight pregnancies no milk was secreted proves the contrary.

This deformity, like others, is at times hereditary, but not being a self-evident one, the fact of its being so is not often to be made out. Both Bruce and Leichtenstern failed to find evidence in any of their cases of heredity, and it is mentioned in only seven out of ninety-two cases recorded before these authors investigated the subject afresh. M. Robert has, however, reported the case of a woman with a supernumerary breast, whose mother had the same anomaly, and Dr. B. Woodman saw a mother and daughter each of whom had three nipples. Dr. Handyside has reported a case where two brothers had four breasts each, the two supernumerary glands being placed below the normal mamma, but nearer the median line of the body.

Supernumerary mammæ are found at times in strange places. Two instances of supernumerary glands have been recorded by Leichtenstern as having existed upon the back. Both have, however, been taken from old works; one from Paulinus, and the second quoted by Helbig. Leichtenstern accepts the cases as true, and upon his authority I name them. Klob has recorded one case in which the mamma was placed over the acromion process of a man, and was the size of a walnut; it had also a good nipple. In M. Robert's case the abnormal gland was placed "on the outer part of the left

thigh, four inches below the great trochanter, and was about the size of a lemon. It was the seat of pain, and of sensations like those of the normal breasts, at the catamenial periods. The possessor of it had suckled several children with the third breast. The mother of the woman, aged fifty, had three breasts, all in the chest." M. Jussieu reports the case of a woman who had a third breast in the groin, with which lactation was performed. "I know of no case in literature," adds Leichenstern, "where accessory breasts or mammæ have been met with below the inferior border of the ribs upon the abdomen." Bruce has, however, recorded in his paper two, if not four cases in which it was clear that the supernumerary nipples had an abdominal position.

The existence of axillary mammæ cannot be doubted. Leichtenstern has recorded five, one of which he saw. It was in the left axilla, and had associated with it a supernumerary nipple below and internal to the normal one of the same side.

A. Förster has recorded a case in which the supernumerary breast was in the axillary region and the seat of carcinoma.

A. H. Cameron recorded[5] a case of a pregnant woman who had an axillary swelling, in which there was a small orifice, but no nipple from which milk could be squeezed. Cohn also, at a meeting of the Berliner Medizinische Gesellschaft in February, 1885, exhibited a patient precisely similar to Cameron's. Cameron, in his paper, suggests that if morphological theories fail to explain the abnormality which he had described, we may accept Laycock's view that the mamma is simply an enlarged and highly developed sebaceous gland, and might make its appearance in any part of the body.

Since the above remarks were written, Dr. Champneys has described, in an able paper on the development of mammary functions of the skin of lying-in women,[6] thirty cases of what he has termed milk-producing tracts of integument, or axillary lumps. These were mostly on the right side when not symmetrical, and were developed generally *pari passu* with the breast.

The secretion from the lumps was of three principal kinds: (*a*) granular débris, like the secretion of sebaceous follicles; (*b*) colostrum; (*c*) milk. It was expressed from the situation of the sebaceous follicles, as marked by the situation of the hairs. The whole surface of the lump produced secretion;

there was no centralization. These axillary lumps seem to prove that in lying-in women the sebaceous follicles of the skin are capable of producing true mammary secretions. They confirm the opinion that the breast is a highly specialized aggregation of highly specialized sebaceous follicles. The least specialized form is that here described, where the skin is merely thickened, and the sebaceous glands produce true mammary secretions. The next form is that where there is an aggregation of the ducts which open by one or more external pores. The highest rudimentary form is where an extra nipple or more is superadded to the last variety. It is also well known that nipples may be developed independently. It is far from improbable, adds Champneys, "that these 'axillary lumps' may share the pathological affections of the breast, and even be the seat of abscess." I would go farther and add neoplasms, for I believe the existence of these lumps may explain the occasional existence of primary sarcomatous or cancerous tumors in the axilla, or beneath its anterior fold, which otherwise are difficult of explanation.

CHAPTER III.

HYPERTROPHY AND ATROPHY OF THE BREAST.

Hypertrophy.—When a breast gland is universally enlarged it is said to be hypertrophied, and the enlargement is supposed to be due to a simple increase in the normal structures of the gland, and not to either an overgrowth of any one of its structures, or to the presence of a neoplasm or new growth.

The hypertrophy in the case of the breast is supposed to be similar in kind to that of other parts, in which from increase of function there is increase of nutrition, and as a result the elements of the structure grow and multiply to enable it to perform increase of work. How far this analogy is correct may be open to a question, since it is quite certain that in some so-called hypertrophied breasts there is little or no breast secretion, even when the non-hypertrophied gland has been brought into full activity by pregnancy; and, further, that a large proportion of examples of this affection is met with in single women, and some examples in male subjects.

A woman, aged 43, came under my care some twenty-five years ago with an enormous right breast, which had been steadily increasing in size for thirteen years; it was when seen at least six times the size of the left gland; it hung down heavily, and caused distress from its mere weight. Its nipple was natural. The woman married, became pregnant, and was confined naturally. She suckled her child comfortably from the left and unenlarged gland; the right so-called hypertrophied gland gave no milk, and although it enlarged somewhat during the first few weeks of lactation, it neither gave rise to trouble nor showed signs of physiological activity.

With these facts before us, the enlargement of the breast can hardly with any correctness be called a hypertrophy, since the gland structure itself gave no evidence even of its normal

development, much less of any increase in its structure; and the functions of the enlarged gland, even when stimulated by a completed pregnancy and lactation, failed to come up to the point of normal secretion.

Many years ago the same point was demonstrated in the case of a young married woman, aged 25, who came to me with an immense right breast of some years' growth, and a complaint that from some mechanical cause her husband could not have complete intercourse with her. On examination I found she had a double vagina and a bifid uterus, and form these facts the sexual difficulty of which she complained was fairly explicable. I told the patient that probably a division of the vaginal septum by means of the galvanic cautery would prove of service, and while she was considering the point, the question of pregnancy arose, as she had missed a period. The surmise of its possibility turned out to be true, and in due time she was delivered of a boy. The enlarged breast, however, never secreted milk, though the small or normal gland gave abundance. All sexual difficulty had vanished. It is interesting to note that in this case of enlarged breast, as well as in one of supernumerary nipples previously recorded, the genital organs were abnormal.

I have before me notes of five other cases of hypertrophy of the breast which occurred in women, and of four in men. Of the five female cases, four were single and one a married woman; the latter was 33 years of age, and the right gland was affected. Of the single women, in three the ages were respectively 19, 21, and 25 years, and the left gland was the one involved; in the fourth case the girl was 17, and both glands were implicated.

One of the single women, aged 21, had a sister under my care for a large adeno-sarcomatous tumor the size of a cocoanut, which I successfully removed. In two of the five cases the catamenia were quite regular, in three this was not the case.

Of the four male subjects, one was a tailor, aged 25, and his left breast was as large as a well-grown woman's; one was a hatter, aged 31, the affection was in his left breast, which was as large as an orange; it had been growing for six years; the third case was a man, aged 20, the right breast had been increasing for three years in a painless way, and was

the size of a fist; the fourth case was a boy, aged 18, and his left breast, which had been growing for two years without pain, was the size of a half a large orange.

It is worthy of note that of the ten cases recorded in which one gland was affected, in six it was the left.

The most striking example of this affection I saw in 1865 with my friend Mr. Shipman, of Grantham. It was in a single woman aged 19, and both breasts were affected. They had been increasing for a year and a half, and were removed, at an interval of three months of one another, by Sir W. Fergusson. One specimen is now at the College of Surgeons (Prep. 4,739). The gland on removal measured one foot in diameter, and weighed thirteen pounds. Except in its increased size and in the corresponding size of the blood-vessels, which (in the preparation) have been injected, there is no apparent change from the normal condition, although on microscopical examination the normal glandular structure was found to be mixed with a great increase of fibrous tissue. The adjoining engraving was taken from this patient.

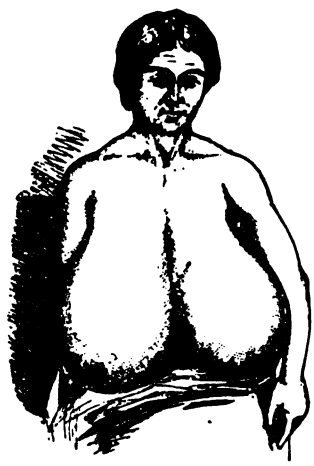

Fig. 1.—Hypertrophy of Breast.

The reader should remember that this affection may be simulated by the presence of new growths, such as lipomata, enchondromata, or adenomata. In the Guy's Hospital Reports for 1841 (vol. vi., p. 203), a case of this supposed trouble is reported, which turned out in 1843, when Mr. Stanley removed it, to be an adeno-fibroma.[7]

No treatment appears to have any effect in these cases except excision, which is to be performed only when the local affection is a source of serious trouble.

There is no evidence to show that this so-called hypertrophy of the breast has any connection with an inflammation. The breast in these cases, in both male and female subjects, may occasionally be more tender than the unenlarged gland, but this symptom is not always present. In the case of in-

flammation of the breast in the male subject recovery generally follows treatment, and I have not seen one instance in which such enlargement became permanent.

Atrophy of the Breast.—By this term is meant the diminution in size due to a wasting of the secreting structure of the breast, the result either of old age, or of some antecedent inflammatory or other change by which the nutrition of the gland has been interfered with.

When it accompanies old age, it is a physiological and consequently a natural process; the breasts with the procreative organs wasting like other glands as soon as they have played their parts in the animal economy, and are no longer wanted for active service. When it occurs during the functional activity of these same organs, the wasting cannot be so explained, and the conclusion has to be drawn that the gland has either not been fairly formed to perform its functions when called upon, or that some pathological change has taken place in it by which its secreting power has been crippled or destroyed. The former explanation is illustrated when a breast which is apparently healthy fails to develop and secrete milk during pregnancy, and the subsequent lactating period (agalactea); and the latter, when a breast which has once performed its functions normally becomes the seat of inflammation, possibly of suppuration, and recovers, and then fails to respond to the physiological demand made upon it by another pregnancy.

In the wasting of old age, there may be no external or visible signs of atrophic changes, the development of fat in and about the gland rendering the actual state of the part obscure; nevertheless, on making a section of such a breast, the anatomist will often find a difficulty in distinguishing the gland, since what remains of it will consist mainly of the nipple and its ducts radiating into the fatty and fibrous tissue with which it is surrounded, the ducts often containing a thick mucus. The surgeon also will frequently be surprised to find, when removing a breast the seat of an infiltrating carcinoma, how limited the disease appears to be, although the mass removed may have appeared large; the infiltrated and contracted mammary gland presenting on section a limited tumor surrounded with fat (Plate 3, Fig. 3).

In the museum of the College of Surgeons there is speci-

men (Prep. 4,819 B) of extreme atrophy of the gland which I removed in 1883 from the person of a lady, aged 65, supposing it to be a carcinoma. It is described in the catalogue as follows: "An extremely atrophied breast, two and a half inches in diameter, of which the nipple is enlarged by a growth of dense fibrous tissue, both within and beneath it, and is pyramidal in shape. The other parts of the gland are of firm fibrous texture, but are less dense than the nipple." With the microscope, only fibrous tissue and a few compressed, atrophied ducts, but no cancerous growth, could be found.

Protracted or frequently repeated lactation is often followed by a rapid diminution in the size of the glands, and in exceptional instances even to their apparent complete loss. In some cases this rapid wasting is real, while in others the breast gland, although apparently gone, rapidly reappears under the stimulus of a pregnancy, and becomes in due time well prepared to discharge fully its natural functions.

Some breasts, likewise, that have been the seat of an inflammation, or of a limited suppuration, are rendered permanently unfit for duty; while, on the other hand, glands that have been scarred all over from abscesses and incisions, and which might be supposed to have been so injured as to have been rendered physiologically useless, reassume, on the recurrence of their natural stimulus (pregnancy), their lactating functions; indeed, such breasts seem to secrete more fully than others that appear larger. The size of a breast, *per se*, is no real indication as to its secreting power, small glands frequently yielding more milk, and more readily, than large ones.

When tumors develop in a breast, its secreting functions may not be much interfered with, for I have known women with adenomata suckle freely, and one with a cancerous breast nurse as well on the affected as on the sound side.

CHAPTER IV.

INFLAMMATION OF THE BREAST.

THIS affection occurs at all periods of life, and in every condition of the organ; that is, it may be met with even in male or female infants soon after birth; in boys and girls at the age of puberty; in women who are pregnant or lactating; as well as in any subject male or female, who may have been locally injured. Traumatism, under all circumstances, has a powerful influence in exciting the affection, and the more so when the gland is in a condition of functional activity. In exceptional cases the affection may occur in men or women without any assignable cause.

The inflammatory action may be acute or chronic. It may terminate in resolution, or in the formation of an abscess. It may involve either a single lobe of the gland, or the whole organ. At times the inflammation will involve rather the periglandular areolar tissue than the gland tissue itself; on still rarer occasions it will affect the connective tissue behind the gland, and give rise to a retro- or submammary, abscess.

I propose, therefore, to consider this affection under three headings, as it is met with during the period of infancy, at puberty, and during pregnancy and lactation.

Inflammation of the Breast as seen in Infants.—This is by no means an uncommon affection, and although it may occur without any assignable cause, it is, in the majority of cases, due to the rough manipulations of nurses who have not wholly escaped the unenlightened influence of the "Gamp" school, and think it right either to "rub away the milk," or "break the nipple strings" of infants three or four days old, a practice which has only to be alluded to to be condemned. It should be well known that the breasts of infants of both sexes during the first few days of life not infrequently contain a secretion of milk somewhat similar in character to that of the

mother; that is, it is made up of fluid containing colostric bodies and milk globules in different proportions. The breasts under these circumstances become full, and, as a consequence, tender, and at times a milky fluid escapes from the nipple. The glands are fullest from the fourth to the seventh day, and after that, if left alone, they gradually empty. In exceptional cases they may increase in size, inflame, and suppurate; and, should they be roughly manipulated, squeezed, or rubbed, these changes are almost sure to follow. The majority of cases of irritable or inflamed breasts in the infant, if rightly treated by soothing warm sedative applications, such as the subacetate of lead and opium lotion, and protected by cotton wool from external pressure, generally do well. The cases that suppurate come to the surgeon, and in these the breasts have usually been roughly treated. When they suppurate they must be opened, drained, irrigated by some iodine or other antiseptic lotion, and treated as an ordinary abscess.

In 1864 I saw a female infant, aged two weeks, with inflammation of both mammary glands, and the inflammation had clearly followed rough manipulation. The glands were much swollen, and the nipples were quite depressed in the centre of the swellings. One breast (the right) suppurated, the left recovered by resolution. The nipple, however, remained retracted. I give this case as an example of retraction of the nipple from early inflammatory action, believing that such cases may be more common than is usually believed.

An abscess may, however, occur in a child's breast at a later period than a month. I saw one in 1868 in a female, and apparently healthy, child eight months old. The left breast was acutely inflamed and it had become so a week before without any known cause. The gland suppurated, and was opened and treated with a good result.

Inflammation of the Breast as met with at Puberty.—At the age of puberty, even in the male subject, there may be signs of increased activity in the mammary gland, as indicated by greater fulness of the breast, with tenderness; of darkening of the areola and nipple. Occasionally this increased action goes on to inflammation and suppuration.

In the female subject, remarkable structural evolutionary changes take place in association with the growth and development of the ovaries and sexual organs, and under such cir-

cumstances there are frequently present external and visible signs of this activity, which may last either for a brief period, and then disappear never to return, or may reappear with more or less force at every return of the catamenial period. Should anything occur from without, such as injury, or from within the gland during its active growing time of life, to interfere with natural evolutionary changes, inflammation may ensue, and either subside or end in suppuration. It is, however, a rare event for a breast, during the period of its development, to suppurate.

On June 2d, 1862, such a case came under my care in the person of Fanny R., a healthy-looking girl, aged 15, in the form of an acute abscess in the right breast. It had commenced without any known cause two weeks previously, that is, on the sixth week after her first catamenial period. The breast had, during the whole of this time, been swollen and painful, but the left ceased to be so as the right inflamed. When I saw her the abscess was pointing, and it seemed to have involved the whole gland. It was opened by means of incisions radiating from the nipple, and treated on ordinary principles with tonics. In three weeks she was well. I have the notes of a like case which occurred in the right breast of a girl, aged 13, in whom the abscess and the appearance of menstruation were concomitant.

When the catamenia are established, and the breast gland has reached virginal developmental perfection, inflammation and suppuration are more common. It may occur as an acute or chronic affection, and possibly the latter is the more frequent. In the majority of cases no adequate cause for the trouble can be found; in some an injury has been clearly the cause. Under both circumstances the inflammatory action more commonly attacks the whole gland than a single lobe. In some cases it involves both glands.

Illustrative cases of this affection will possibly here best prove of value.

CASE I.—Acute abscess in both breasts of a girl, aged 15:

Maria C., a healthy-looking girl, aged 15, who had menstruated for two years, always with pain, applied to me in June, 1865, with an acute abscess in her right breast of six days' formation. There was no history of a blow. The ab-

scess was opened and healed. Two years later, on April 22d, 1867, the girl came again with another abscess in her other breast of nine days' standing. This was treated by incision and tonics with a good result.

CASE II.—Acute abscess in virgin breast:

Mary S., aged 16, came before me at Guy's Hospital on May 10th, 1858, with an abscess in her right breast, which had been discharging for one week, after acute inflammation of three weeks' standing. The abscess apparently involved half the gland. No blow or known cause could be assigned for its existence. The catamenia were regular. The opening, being insufficient for the free discharge of pus, was enlarged, and the cavity of the abscess washed out. In one month the girl was well.

CASE III.—Chronic inflammation of both breasts in a virgin:

Emma S., a healthy-looking girl, aged 15, came under my care on July 7th, 1861, for chronic inflammation of both mammary glands. She had menstruated but twice, and it was after the last period, on March 29th, that her breasts began to enlarge. When seen the breasts were swollen, hard, hot, and painful. There was also some vaginal leucorrhœa. Fomentations were applied, and iron given as a tonic, and in the course of a few weeks the swellings had subsided.

In many cases a breast may inflame without injury or known cause, and recover by resolution without suppurating. In the one I am about to record, the inflammation never went beyond the œdematous stage, and then passed away. It is the only example of the kind that I have met with. For this reason I record it. The case explains the treatment that should be employed under similar circumstances.

CASE IV.—Œdema of breast (inflammatory?); recovery:

EllenO., aged 19, a single woman, consulted me on July 25th, 1864, for a great enlargement of her left breast, which had been coming on for four months. The whole gland was swollen, and the integuments over it were thickened and tensely œdematous, but neither red nor hotter than natural. No cause was assigned for the trouble. Some punctures were made into the tense skin, and much serum exuded. In one week all swelling had disappeared, and in a month the girl was well.

Inflammation of the Breast during Pregnancy and Lactation.—Inflammation of the breasts is most frequently met with in women who are, or have been, suckling. It but rarely takes place when the mammary glands are undergoing their physiological changes preparatory to suckling. When the breasts are preparing to discharge their normal function, there may, in the early months of pregnancy, be symptoms and signs of increased activity, but such rarely lead up to inflammation, unless stimulated by some external injury. Out of one hundred and two consecutive cases of abscess of the breast which have passed under my observation, seventy-nine occurred during lactation, two during pregnancy, and twenty-one in patients who were neither lactating nor pregnant. Thus, roughly stated, four out of every five cases of abscess of the breast occur in lactating women. The right breast seems to be more frequently affected than the left. In my own patients this was the case in the proportion of five to three.

Birkett states that this complication of lactation occurs chiefly in women who have given birth to a first or second child. That half the cases are associated with defective nipples, and another fifth with women whose nipples are unhealthy. Thus, he adds, "we have more than two-thirds of the cases of inflammation and its results complicated with, and probably excited by, malformations or diseases of the aggregation of the excretory ducts constituting the nipple."

The affection commences usually during the early or late months of lactation. In two-thirds of my own cases it occurred during the early periods, that is, in the first two months; and in two-thirds of these during the first month. In the remaining third it commenced during the last month. Mr. Birkett's statistics support these conclusions; fifty-eight out of his one hundred and sixteen cases having commenced during the fourth month after parturition, eleven during the second, and forty-seven during the later periods.

It would thus appear that inflammation of the breast is mostly in the early months due to some abnormality or affection of the nipple which renders suckling difficult, if not impossible, and in the later it is probably due either to protracted lactation, and to the exhaustion of the mother's general and of the breast's special powers to secrete milk, or to the abrupt

discontinuance of suckling from the death of the infant or other cause. In some of the cases I believe, with Mr. Ballard, that abscess in the early months is due to the searching of the child after milk before the gland is filled, in patients who have not sufficient power either to secrete milk or to resist the inflammatory process when once originated. In others, again, it is brought about by the injudicious use of a milk pump. In fact, whenever "the mamma, in its state of full expansion and perfect functional activity, becomes the subject of an interference, the result is very commonly a diffuse or nodular inflammation, and the formation of an abscess. A sudden stoppage of the milk soon after the lactation has been established is apt to produce inflammation, and the same result, or a degree of it, sometimes follows the weaning of the child after a long course of suckling. The disturbing cause, whatever it may be, acts upon the mamma when its function is at its greatest intensity, and the characteristic effect is inflammation and abscess" (Creighton).

Symptoms of Inflammation of the Breast.

As congestion of the blood-vessels is the earliest pathological change in the tissues of a breast that is about to inflame, so a greater fulness, with more or less induration of the affected part, is the earliest symptom. When the action is confined to a lobe of the gland the increased fulness will be local; when it involves the breast as a whole it will be general. This symptom of fulness will be readily detected on comparing the sound with the affected side. With this early symptom there may or may not be pain, unless uneasiness of the part, aggravated by movement of the arm, local pressure, or suckling can be called pain. But as the disease progresses, pain will soon manifest itself, and its intensity will turn upon the activity of the affection, or the nervous susceptibility of the patient, but more particularly upon the tension of the inflamed lobe or gland. This tension of the inflamed part is determined by the seat and amount of effusion poured out by the inflammatory action, or by the rapidity with which it has been effused.

With these early local signs there will probably be some constitutional symptoms, as shown by increase of temperature and the general disturbance of all the functions of the

body, which usually accompany every febrile action. At times, even in the very early stages of the affection, a sense of chilliness may precede the local trouble, and in rarer cases a distinct rigor may occur; but this latter symptom is more frequent in women who are suckling than in others, as in them the local congestion and inflammation of the breast is usually preceded by some local disturbance of the breast, and this local disturbance gives rise to rigor.

In lactating women local congestion of the breast is not uncommon. It may either subside without giving rise to any true inflammatory action, or pass on to acute suppuration, the ultimate issue of the case being much determined by the treatment it receives.

When it occurs, it is commonly called a lump, knot, or coring of the milk, and the lump or knot is essentially a lobe of the breast, which is choked with milk or its more solid constituents; this is commonly called lobal congestion. In more severe cases, all the lobes become thus affected, when the affection is called "lactic congestion."

If this local congestion of the breast does not pass on to inflammation, the skin over the gland will remain healthy, and beyond some fulness of its veins appear normal. The congested gland or lobe will, moreover, not be tender; indeed, it may tolerate manipulation freely, and find benefit from gentle friction, the friction apparently rendering the induration less marked, and relieving the congestion.

When this congested condition of the lobe or gland passes on to inflammation, the action is, as a rule, acute, and the induration of the part primarily involved spreads to the tissues around, and gives rise either to œdema, or to a brawny infiltration of the surrounding structures. When the inflammatory action spreads forward, the skin over the affected gland will become swollen, red, and more or less œdematous, tense, and painful, and with these local symptoms there will be the constitutional disturbance of inflammatory fever.

When the parts behind the gland are more involved than its coverings, there will be the same constitutional symptoms as have been described as attending the more superficial inflammation, but the local symptoms will be somewhat different, the difference being due to the presence of the inflammatory products behind instead of in front of the gland. From

this cause there will be less superficial redness and swelling, but a greater prominence of the breast (see Plate I. Fig. 2), and a sense of deep instead of superficial effusion. The progress of the affection will also probably be slower, and there may be more pain.

Should the inflammation continue, or rather not recede, and suppuration take place, many varieties of abscess may be met with, the position of the abscess being determined by many causes. Thus, there may be a local abscess confined to a single lobe, or a diffused one involving the whole or more or less of the gland (intraglandular abscess). In some cases the suppuration will appear to be superficial, and confined to the connective tissue between the gland and its coverings (superficial abscess); while in others it will be placed behind the gland between the breast tissue and the pectoralis major, and develop as a submammary abscess. In rare cases the abscess forms independently of the breast, as in the cases reported farther on, but in the majority the breast gland is involved in it. The progress of the affection under these different circumstances will vary, and this variation consequently claims some little attention.

Superficial Abscess.—When the abscess is superficial, the progress of the affection from the first will probably have been rapid, and although marked with the well-known local phenomena of inflammation, it is unusual for it to be accompanied by any severe pain, or associated with general constitutional symptoms. This mildness of symptoms is explicable by the fact that there is little tension upon the tissues, the skin readily yielding to the inflammatory effusion. Should, however, the inflammatory action involve a large proportion of the connective tissue which surrounds the mammary gland, there may be both severe local as well as general disturbance. In feeble and cachectic subjects this extension of mischief is very apt to take place, when from any cause a local inflammation has been started about the breast.

Under all circumstances a superficial abscess is prone to be followed by destruction of skin; when the suppuration is diffused, this destruction may be extensive. In patients of average power, a local inflammation terminating in suppuration may run its course, point, and discharge, rapidly, and with little loss of substance.

Intraglandular abscess is a far more serious trouble than the last variety, since its position is in one or more of the lobes of the gland itself; and it is to be remembered that these lobes are surrounded by a fibrous fascia, which when distended must give rise to pain. This affection is consequently attended from the first by comparatively severe local as well as constitutional symptoms.

The inflammatory action, moreover, since it involves deep structures, is comparatively slow in its progress, or rather, it is slow in developing the symptoms which are usually regarded as typical of a local inflammation; for to demonstrate these, the action which originated in the gland has to spread through its fibrous envelope to the surrounding tissues, and from them to the skin. Thus it is that in this form of inflammation many days, or even weeks, may pass in which there may be deep mammary swelling, intense local pain, and severe constitutional disturbance without local redness or any marked external evidence of cutaneous implication. These superficial palpable symptoms only show themselves when the inflammatory action has passed through the fascial envelope of the affected lobe of the gland, and secondarily involved its cutaneous coverings. The local pain in the early stage of this true mammary inflammation is often intense; it is the direct result of tension of the tissues into which the inflammatory effusion has been poured, and it continues until this has been reabsorbed, or the fascial covering of the affected lobe has yielded to the pressure from within and allowed the pent-up fluid to infiltrate the surrounding parts.

During the early progress of this affection the constitutional symptoms are correspondingly severe; indeed, within two days of the earliest discovery of an indurated and inflamed lobe of a lactating gland, symptoms of acute pyrexia may appear, and they are frequently associated with serious brain excitement and disturbance.

As the local affection progresses and tends toward suppuration, the local and general symptoms alter, although as to their intensity they rarely diminish. The severe burning lancinating pain which ushered in the trouble, changes into a heavy and distressing throbbing pain, and a rigor is superadded to the general condition of pyrexia. Indeed, from this stage of the affection, onward, periods of fever, rigors, and

sweating follow one another. The original seat of hardness in the breast steadily increases, until a greater part or the whole of the gland becomes equally involved; and the breast at this stage of the trouble feels large, and irregularly indurated, with the skin over it uninvolved, and the nipple often retracted. As the abscess progresses, the skin over the breast will become involved, showing redness and œdema; or even before, if the breast is carefully examined, the surgeon may detect at the original seat of induration a soft and painful spot, which to the experienced finger at once reveals the fact that the abscess is coming forward and will soon burst. As soon as the abscess has burst, relief to both local and general symptoms is at once experienced, and in the most favorable cases repair sets in, and recovery is not far distant. To illustrate this subject I append a few typical cases.

CASE I.—Acute abscess of breast coming on during the seventh month of pregnancy:

Susan G., aged 26, the mother of four children, all of whom she suckled without trouble, came to me on January 15th, 1866, with an acute abscess in her right breast, which had been coming two weeks. She was then pregnant seven months. The abscess was treated by incision, and rapid recovery took place. She subsequently had a natural labor, and could suckle with the breast which had been affected.

CASE II.—Abscess in the breast during the third month of pregnancy, with retracted nipple:

A woman, aged 37, the mother of one child three years old, came under my care on March 13th, 1867, with a tumor in her left breast of six weeks' standing; the nipple had been retracted three weeks; there were also enlarged axillary glands; she was pregnant three months. On April 2d the swelling becoming fluctuating, was opened, and pus evacuated. By May 9th the abscess had healed, leaving the gland indurated; the pregnancy continued to the end.

CASE III.—Chronic abscess in the breast; recovery; two years later acute abscess in the same breast after pregnancy:

Eliza F., aged 32, the mother of four children, the youngest being two years old, came to me in September, 1867, with a swelling in her right breast of eight months' standing. She had never suckled with her right breast, as the nipple was

tender. The nipple had discharged a watery fluid up to the last month. The axillary glands were enlarged. The swelling was globular and semi-fluctuating.

The tumor was punctured and eight ounces of pus escaped; it was then laid open and rapidly cured. On January 4th, 1869, the patient returned with an abscess in the same breast of five weeks' standing which had followed labor nine months previously, though she had not suckled. This was opened later on and a good recovery followed.

CASE IV.—Abscess in breast following inability to suckle on account of deformed nipples:

Henrietta D., aged 25, came under my care in January, 1879, with an abscess in her right breast. It had followed closely upon her confinement nine weeks ago, and was clearly due to her inability to suckle on account of depressed and deformed nipples. She had had plenty of milk. Both breasts inflamed, but the right alone suppurated, and burst, discharging a pint of pus. The left breast recovered by resolution.

CASE V.—Intraglandular abscess following ulceration of the nipple:

Rosie F., aged 35, the mother of four children, the youngest being thirteen weeks old, came into Guy's in February, 1874, with an abscess involving the outer half of the left breast. She had not been able to suckle the last child with either breast on account of sore nipples. On admission, the nipples were extensively ulcerated, and in the outer lobe of the left breast there was clearly an abscess, as indicated by the presence of a deep fluctuating swelling and redness with œdema of the skin over it. There was likewise much pain and general disturbance. An incision was made into the abscess, which was then washed out and drained, and in about a month the woman was well.

It seems that with her first child, born fourteen years ago, she had an abscess in her right breast, which broke in six weeks, and slowly recovered. Her second child she nursed at both breasts. With the third the left breast suppurated.

CASE VI.—Abscess in both breasts consecutive, retracted nipples as a result:

Rachel B., aged 28, a married childless woman, came under my care on November 10th, 1864, with a globular swelling in the centre of her right breast, and a retracted nipple. The

swelling had been coming on a week, and the nipple had become retracted during that period. The left nipple was normal. In a few days fluctuation was discovered, and the abscess was opened. Three months later the patient came again with the same condition of her left or opposite breast, and a retracted nipple. This likewise suppurated, and was treated. Both nipples were, however, retracted subsequently.

CASE VII.—Abscesses in the virgin breast of a woman, associated with retracted nipple:

Charlotte C., aged 25, a single woman, came under my care on May 5th, 1885, with a swelling three inches by two and a half in the centre of her left breast, which had been coming for three weeks. It was hard and tender to the touch. The skin over it was natural. Nipple retracted, this retraction began with the swelling and shooting pain; no enlarged axillary glands. The tumor was supposed to be inflammatory, cold was applied by means of a Leiter's metallic coil for several weeks with advantage, the swelling diminishing; as soon as it was given up the swelling, however, increased, and an abscess formed, which was opened, drained, and cured.

CASE VIII.—Nodular tumor (inflammatory) in centre of breast simulating carcinoma, following lactation, which disappeared under treatment:

Phœbe T., aged 30, a married woman, the mother of one child, now fourteen months old, came to me on October 21st, 1861, with a central tumor in her left breast which had been pronounced to be cancerous. It had been coming for five months, and had appeared three months after giving up suckling. It was not very painful, but was nodular. The nipple was natural. There was no redness, and but little pain. It was treated as one of inflammatory origin, and strapped up. Tonics were also given. In the course of about two months the swelling disappeared.

Submammary Abscess is, as a rule, still slower in its progress than the intraglandular; although, in exceptional cases, it may be comparatively acute. It is characterized by a remarkable projection of the breast forward from its thoracic attachments (Plate I., Fig. 2), and on manipulation, and more particularly on applying pressure backward upon the gland, a sense of elasticity and fluctuation will be detected, which is most characteristic.

The skin covering the breast at this time may be natural, and there will probably be no change in the appearance of the nipple. Pain will rarely be severe or constitutional symptoms serious. As the abscess spreads, and by making its way to the surface involves the integument, both local pain and constitutional symptoms become aggravated. The periphery of the gland will probably be the seat of pointing, and as a rule, the area of redness will be extensive; it may at first show itself in two or more local red patches, but these areas of redness will soon unite, and perchance spread in all directions; after a time the skin will give way by ulceration and sloughing, and the abscess discharge itself. The orifices of discharge are generally multiple. In exceptional cases the abscess discharges through the gland, when the orifice is placed near the sternal side of the nipple, where the gland is the thinnest.

CASE I.—Acute submammary abscess after delivery; death from lobar pneumonia:

Alice P., aged 22, was admitted into Guy's Hospital on February 11th, 1875, with a submammary abscess of her left breast. It had come on after her confinement six weeks previously. The left breast was not apparently larger than the right, although it stood out from the chest in a very prominent way; deep fluctuation beneath the breast was to be felt. An incision was made into the abscess at the lower margin of the gland and much pus evacuated; in a few days a second incision was made higher up. Chest symptoms soon appeared, with great elevation of temperature, and the patient sank. At the *post-mortem* it was found that the woman had died from lobar pneumonia of the left lung; that a large abscess cavity existed between the left breast and the pectoral muscle; and that the breast itself was quite healthy. All the other viscera were healthy.

When this affection has been allowed to run its natural course numerous sinuses are often present, their orifices being situated around the margin of the gland.

CASE II.—Sinuses in both breasts following submammary abscesses two and a half years previously, treated by binding the arms to the sides:

Mary M., aged 43, the mother of five children, the youngest being four years old, came under my care on February 21st,

1861, with both breasts riddled with sinuses discharging pus, the orifices of the majority of the sinuses being at the periphery of the breasts. These had existed for two and a half years, and had followed acute suppuration of both glands after prolonged suckling. No treatment had been successful. The sinuses were syringed daily, and the breasts strapped. Tonics were also given. Improvement followed, but no cure, until the arms were bound to the sides to prevent muscular movement, after which a rapid recovery ensued.

Treatment of Inflammation of the Breast.—Inflammation of the breast is to be treated upon the same principles as inflammation of any other organ; the object of the surgeon being, if possible, so to check the action in its early stage as to bring about a recovery by resolution, and where this desirable end is not to be secured, to limit the amount of mischief in the gland, and to prevent, when suppuration has taken place, more damage to the gland and surrounding structures than is unavoidable.

It must, however, always be remembered that the breast gland may inflame under very different physiological conditions, and that the treatment of an inflamed gland in a state of physiological inactivity must differ in a degree from the treatment of one either preparing for lactation, as in pregnancy, or in full physiological action, as during suckling.

The puerperal or non-puerperal condition is a consideration which should therefore ever weigh with the careful surgeon, and in the consideration of its treatment it consequently seems to be wise to divide cases of inflammation of the breast into two classes.

The first including such as occur in children and women quite independently of the puerperal state.

The second those that are associated with, or follow, either pregnancy or suckling.

In Infants.—Inflammation of the breast in the non-puerperal state, as it occurs in infants, should not give rise to any serious trouble; and it may probably be said with truth, that it would hardly ever occur, if the breast had not been squeezed, pressed, or damaged, by the fingers of rough nurses who are imbued with wrong impressions.

Should, however, any inflammatory action show itself, the

application of a pad of Gamgee tissue or absorbent cotton dipped in warm lead lotion, will, as a rule, cause it to disappear without suppuration. To prevent a recurrence of the action, the breast should be protected with cotton wool, and due attention paid to the dresses, that they should not press or irritate the part.

When suppuration has taken place the abscess should be opened as soon as it has formed, the puncture or incision being made in a line radiating from the nipple. The abscess cavity should be well washed out with iodine water, that is, a lotion composed of about two drachms of the tincture or one of the liquor iodi to a pint of water; and some simple dressing should be subsequently applied, such as a piece of folded lint saturated with a mixture of terebene (one part) and olive oil (four parts); and bound over all a small sheet of Gamgee tissue. With such treatment the abscess will heal. When burrowing has taken place, and the contents of the abscess do not pass away readily, the cavity should be washed out daily with the iodine water; in exceptional cases a drainage tube may be required.

In Girls.—When inflammation attacks the breasts of girls at the age of puberty, when they are in a state of evolution, the local application of warm lead lotion, with or without the addition of opium in solution, in the proportion of five grains of the extract to an ounce of lead lotion, will always be beneficial; when the action is high, saline purgation is useful, and when the patient is weak, tonics may be called for, quinine being the best. As the acute stage subsides, the local application of the extract of belladonna diluted with glycerin, or rubbed down with vaseline or lard in the proportion of 3 i. to an ounce, soothes the pain, and expedites recovery. In painful breasts, in which inflammation may be expected, this local application of belladonna may be all that is called for. In all cases of inflammation the arm is to be fixed to the side, to check action of the pectoral muscles upon which the breast rests, and the inflamed mammary gland should be supported. In severe cases, where suppuration is threatened, the horizontal position should be maintained.

In Women.—Inflammation, as an acute affection, when it attacks the breast of women who are neither pregnant nor lactating is usually the result of injury. It occurs, however, without any such cause. It is, as a rule, periglandular;

when intraglandular it is usually chronic. It is to be recognized by the same symptoms as have been described above, and it should be treated on like principles. When it first appears, it may, however, be checked by the local use of cold, applied as an ice-bag, or by what is better, Leiter's metallic coil, a method of treatment which is of great value in the treatment of all local inflammations, but which is not applicable in the case of pregnancy and lactation. Should suppuration occur, it is to be dealt with as an ordinary abscess; but the gland not being in an active physiological condition is rarely the seat of suppuration.

In Pregnant or Lactating Women.—Inflammation of the breast in the pregnant or puerperal woman is always a more serious affection than when the same trouble affects a woman differently situated; for women in the conditions alluded to are particularly sensitive, and are open to impressions to which others, who are neither pregnant nor lactating, are not exposed. Inflammation, under these circumstances, attacks a gland which is physiologically active, and consequently more prone to become the seat of inflammation under the influence of any traumatism or disturbance of its functions.

The earliest symptom of inflammation of a breast physiologically active is local induration with more or less pain; and this induration indicates a lobular congestion of the gland; indeed, this stage may be described as the "congestive." There will not be any redness, œdema of the skin, or constitutional disturbance of any importance: gentle manipulation of the gland will not be resented.

In the pregnant woman this "congestive" stage, if not due to injury, must be explained by some local disturbance to the evolution of the gland, giving rise to congestion of the vessels and blood stasis, which, if not relieved, will pass on to active inflammation. To relieve it, the horizontal posture, as a means of helping the circulation through the breast, support of the gland by bandage, and gentle friction with pressure of the gland toward its nipple, are of great value; indeed, by these means alone, aided or not by some saline purgative, the symptoms will often subside and leave no mark behind.

In the lactating woman, although the same treatment may be beneficial, the surgeon should examine with care the condition of the nipples, to see if there is any obstruction to

any of the ducts, or irritation about their orifices, and at the same time he should examine the lobules of the breast to see if any are choked with milk, in order that their distention may be relieved, either by the manipulation already described or by some mechanical means. When suckling can be allowed, gentle friction in addition may be sufficient; where this is impossible, some appliance for drawing off the milk should be carefully used. The breast pump I look upon with no favor, since I am convinced I have seen much harm follow its use by injudicious hands. When it is employed, it must be used by the surgeon, and not left to a nurse, unless she be both skilful and judicious. Where the nurse is intrusted with the duty of drawing the breast, the least dangerous instrument is a tube with a mouth-piece for the nurse, or, indeed, the patient, to draw, fastened to a shield to press over the nipple, with or without a small reservoir between to hold the milk. The patient is hardly likely to hurt herself by suction, and the withdrawal of but a few drachms of milk from an over-distended lobule will give relief to pain, as well as to the congestion, and tend to check the inflammatory action. The application of pressure to the breast by means of strapping, at this stage of the trouble is often beneficial. The nipple should be left uncovered, as suckling may be useful.

When there are external signs of inflammation, such as redness; or constitutional symptoms, such as pyrexia, to indicate true inflammatory action, the application of the lead and opium, or lead and belladonna lotion, applied warm, gives great comfort and does good. The patient should under these circumstances maintain the horizontal posture, and the breast should be carefully supported, either by cushions or bandages; one of the former placed between the arm and chest on the affected side is probably the most convenient. As the arm is not to be used, it is well, therefore, at the same time, to bind it to the side with the cushion in position.

Saline aperients are often of value, but they must be judiciously ordered, since they have a lowering tendency, and patients with inflamed breasts are rarely of the strongest build; indeed, with them, as a rule, tonics are indicated, such as quinine, bark, mineral acids, or even iron. When the inflammation occurs toward the end of suckling this is always the case; when it takes place in the early months, as a result

of sore or malformed nipples in milking mothers, purging is of great value. When the external symptoms of inflammation are marked, the constitutional symptoms acute, the powers of the patient good, and the causes of inflammation in the nipple have made suckling impossible, the local application of from twelve to twenty leeches is often of striking benefit; they should not, however, be placed over the seat of redness, but near the margin of the gland on the affected side; by this means the vessels supplying the gland are the better relieved.

During the whole course of treatment the breast must be supported, and where pressure can be tolerated by means of strapping it should be applied.

In every case of inflammation of the breast in a lactating woman, its probable cause should be made out, and treatment based upon it. When the action is due to retained secretion, the primary indications for relieving the congested breast of milk are clear; and the secondary, for subduing the inflammation, which is evidently the result of over-distention, are not doubtful. When it occurs toward the end of lactation, and is too probably the result of over-suckling, associated with general weakness of the body and want of power in the gland to do the work demanded of it, the indications are likewise clear; to stop the cause of trouble by prohibiting suckling, and by medicine, food, and hygienic means to improve the condition of the patient, to enable her by natural power to arrest the disease. When the inflammation is brought about by retained secretion, active measures may be taken with a good prospect of success; when from over-suckling and debility, the conditions under which the inflammatory action starts are most unfavorable, since the subjects of the trouble, and the glands themselves, from over-nursing and exhaustion, show little resistance to inflammatory changes, and time is wanted for the remedies to take effect. Under such circumstances suppuration is almost sure to ensue.

Treatment of Abscess of the Breast.—When suppuration has taken place in a breast, as elsewhere, the soundest surgical treatment is to evacuate the pent-up pus as soon as possible; by so doing the extension of the trouble is prevented, much pain is saved, and the course of the affection is curtailed. The only exception to this rule is where the suppuration is

subcutaneous and very limited, and where the surgeon cannot determine the right point for puncture.

To leave a large subcutaneous abscess to break, is to allow large portions of skin to become underminded and consequently to die. To let a true intraglandular abscess take its course and find its way to the surface, is to waste time, cause much needless pain to the patient, and postpone recovery, and the same may be said of the submammary abscess, for in it, if the abscess is left alone, there must of necessity be burrowing of matter in all directions, and as a result the formation of sinuses, and much unnecessary damage to the breast and parts around. When the abscess is opened, the incision into it should be free, and it should without exception be made in a line radiating from the nipple. By following this line the risks of interfering with the ducts of the gland, and of thus adding to the chances of the gland becoming useless, are greatly diminished, and a reasonable hope may be entertained, even in the worst cases, that the gland may subsequently be able to resume its functions.

When the abscess has been opened, and it is to be assumed freely, so that its contents may readily escape, the abscess cavity should be irrigated with some antiseptic lotion, such as that of iodine, and the walls of the abscess allowed to collapse; pressure should then be applied by means of strapping to keep the walls of the abscess in apposition, and the breast supported; the line of incision should be kept uncovered, and carefully guarded by some antiseptic dressing, to prevent decomposition, such as strips of iodoform gauze dipped in a mixture of terebene one part, olive oil three parts; or carbolic oil one in eighty; and a small sheet of Gamgee tissue, or a wad of absorbent cotton should be fixed over all to absorb the discharge. In some cases, when the pus drains from a deep cavity, a drainage tube may be employed. The incision into the abscess should always be so arranged as to assist the drainage of the abscess, and the cavity of the abscess should be washed daily with iodine water, or some other antiseptic solution, either of carbolic acid, 1 in 80, or boracic-acid lotion, ten grains to the ounce.

In a submammary abscess an incision should be made as soon as a diagnosis of abscess has been formed. The opening should also if posssible be made at the lower or outer border

of the breast, and a drainage tube introduced after the cavity has been well irrigated. The breast should likewise be steadily fixed, by strapping and bandage, to the thorax, so that its movements may be prevented and the walls of the abscesss kept firmly together. In some cases of submammary abscess, or of sinuses following abscess, it is necessary, so as to get a good result, to prevent the movement of the pectoral muscle by binding the arm to the side. In a case already quoted the benefit of this treatment was well exemplified, but in the following it was more striking.

CASE I.—Sinuses about breasts following deep-seated suppuration three and a half years previously, in a young single woman:

Miss M. U., aged 23, consulted me in 1875 for sinuses which riddled both breasts, and likewise the submammary tissues. They had existed on the right side for three and a half years, and on the left for three years. They had followed acute inflammation which had come on without any known cause. Every kind of treatment had been employed without success. I simply strapped up the breasts, leaving the orifices of the sinuses open, dressed the wounds with terebene oil, and bound the arms to the sides to prevent movement of the pectoral muscles. In one month the patient was well.

Tonics are almost always required in all these cases, and of these quinine is the best. Iron when it can be borne is also of value. Good food, with stimulants carefully administered, and good air are likewise essential. When the abscess is quite local, and the general condition of the patient good, nursing may be continued so as to keep the breast free from fulness, although it is not to be recommended; but when the suppuration involves more than a lobe, it must be forbidden as much for the infant's as for the mother's sake.

When sinuses are left after suppuration, they may generally be healed by the careful application of well-applied pressure by means of strapping to insure immobility of the parts about them; when they are of some standing, the injection of a lotion of chloride of zinc of from 5 to 10 grains to the ounce is most beneficial; when they are superficial they should be laid open, and treated as open wounds.

When milk fistulæ are present, that is, when the sinuses following an abscess discharge milk, the same kind of treatment is to be adopted as has been just described for sinuses; their cure is, however, always troublesome; indeed, it is not to be looked for until the breast has ceased to be a secreting organ. When the milk has "dried up," the fistulæ will probably heal up with it, but not before.

The induration which is left after inflammation of the breast will slowly subside as the health of the patient improves, and even after the most extensive suppuration there is a reasonable hope that the breast may so recover its normal condition as to allow of suckling in a later pregnancy. Should there be any malformation, retraction, or disease of the nipple, this result is not, however, to be looked for, but under other circumstances it may be anticipated.

To guard against congestion and inflammation of the breasts of pregnant women, who from local or general bodily condition cannot or ought not to nurse, pressure is by far the most reliable means. This may be applied directly after labor in the form of a chest bandage, or by means of strapping, well adjusted; the pressure mechanically preventing the flow of blood into the breast, which of necessity precedes secretion.

When the stage for pressure has passed, and that of tenderness and congestion reached, the local use of belladonna, diluted with equal parts of vaseline or glycerin, is of great value. Saline purgatives administered with discretion help toward the desired end.

CHAPTER V.

CHRONIC ABSCESS OF THE BREAST.

In a clinical exposition of diseases of the breast, it is clear that chronic abscess of the gland should be considered apart from the more acute forms of inflammation; since examples of this affection differ much from the more acute troubles in their clinical history and symptoms, and are frequently mistaken for new growths, such as cancer. They are met with in women at all periods of life, and attack the single as frequently as the married, and the sterile as often as the prolific. They follow at times some blow or injury, and are occasionally associated with lactation. More frequently, however, they form without any known exciting cause, and are very insidious.

The symptoms are much those of chronic lobular inflammation, although, if possible, less well marked. They are chiefly those which are attached to a local swelling, slowly and insidiously increasing with little or no marked pain. The swelling from the first seems to be part of the breast, and to involve it as an infiltration. In the early stage no other symptoms exist. Later on, there may or may not be œdema and external signs of inflammation; but these points will best be illustrated by cases.

Case I.—Chronic abscess in the centre of the breast of a married childless woman following a blow; nipple retracted:—

Sarah M., aged 25, a married childless woman, applied to me on December 31st, 1863, for a swelling which occupied the centre of her left breast. It had been slowly coming, and had appeared soon after a blow, which she had sustained eight months previously. There had been little or no pain attending its formation. When seen the breast was universally enlarged, and formed a flattened globular swelling, in the centre of which was a retracted nipple. The nipple before the swelling appeared had been quite natural. The tumor was very

hard and slightly tender on manipulation. No sense of fluctuation could be detected in it. A needle was introduced into the swelling for diagnostic purposes, and when pus exuded, a free incision was made into the gland, and several ounces of greenish pus evacuated. A speedy cure ensued.

CASE II.—Chronic abscess in the breast of a single woman, with retracted nipple, simulating cancer:

Ellen A., aged 56, single, applied to me in 1865 for a swelling which involved the whole of the left breast, associated with a very retracted nipple. The breast was very hard, and the trouble had been coming for seven months. The axillary glands were normal. The case looked like one of cancer. In two weeks, however, some signs of fluctuation were felt, and on the introduction of a needle for diagnostic purposes, pus escaped. The abscess was, therefore, opened, and a cure ensued. The retraction of the nipple had been congenital.

CASE III.—Chronic abscess in the left breast of a single woman:

Jane E., aged 32, a single woman, came to me in 1865, with a large abscess, the size of a cocoanut, in her left breast. It had been coming for five months without any known cause, and with hardly any other local symptom than swelling. I tapped it, and drew off sixteen ounces of pus. I then incised and drained it, when a rapid recovery ensued.

CASE IV.—Chronic abscess in the centre of the breast, with retracted nipple, following pregnancy:

Mary R., aged 41, a married woman, the mother of nine children, all of which she suckled except the last, came under my care on August 25th, 1864, with a large central indurated swelling, occupying the right breast, and a very retracted and depressed nipple. The swelling had been gradually coming for nine months during her pregnancy, and during this time the nipple retracted. She was confined at the natural term, and did well. She did not wean the child. When seen the skin over the swelling was adherent to the gland, a week later it was somewhat redder than normal, and, in two weeks some evidence of pointing was discovered near the nipple. An incision was consequently made deeply into the gland, evacuating pus, and a rapid recovery followed.

CASE V.—Chronic abscess in the breast, unassociated with lactation, discharging through the nipple:

Harriet B., aged 40, the mother of four children, the youngest being eleven years old, came to me in June, 1865, with an abscess in the centre of her right breast, which had appeared without any known cause about ten months previously, and had discharged from the nipple three weeks. The breast was large and tender, and pus flowed freely from the nipple. Tonics were given, and pressure was applied to the breast by strapping. In one month all discharge ceased, and some thickening of the breast alone remained, which eventually subsided.

CASE VI.—Chronic abscess in the breast of a married woman, aged 64, without known cause:

Hannah K., aged 64, a married childless woman, consulted me on October 14th, 1859, for an abscess in her right breast, which had been discharging from the nipple, and also from an orifice below the areola for two weeks. A swelling had existed in the breast for about three months previously. It began as a swelling that was not very painful, which slowly increased, and then discharged. It was cured by a free incision and drainage, aided by tonics. The case was thought to have been one of cancer, and on that account was sent to me.

CASE VII.—Chronic abscess of the breast, of four months' standing, in a single woman, mistaken for cancer; excision of gland; recovery:

A. S., aged 50, a single woman, came into Guy's Hospital with a central tumor of the right breast, which had been coming painlessly for four months, and was associated with a retracted nipple. The skin over the breast was healthy, and the lymphatic glands were not enlarged. The surgeon under whom the case was admitted took it to be one of cancer, and consequently removed the breast. Its true nature was then discovered.

CASE VIII.—Abscess in the breast with retraction of the nipple, puckering of the skin, and swelling, in a single woman; simulating cancer:

Leonore W., aged 39, a single woman, came under my care on November 22d, 1866, with a swelling the size of a large walnut in the upper part of the left breast, which had been coming for months, with a nipple which was completely retracted, and with the skin over the tumor puckered and fixed to the parts beneath. The swelling was hard, and situated in the

gland itself. These symptoms suggested a carcinoma. On going into the history of the case, it was elicited that the nipple had been retracted from birth, and that the puckering and adhesion of the skin were due to the cicatrix of an old abscess which she had had twelve years previously. In the course of a few weeks the tumor softened, and its true inflammatory nature was revealed. It was opened, irrigated, and cured.

CASE IX.—Chronic abscess in the breast of a pregnant woman with retracted nipple, and enlarged axillary gland; recovery:

Mrs. R., aged 37, a married woman, with one child three years of age, came under my care, in May, 1867, with a swelling which occupied the centre of her left breast, of six weeks' standing, and which had come on without any known cause. The nipple for three weeks had been retracting, and when seen the axillary glands were enlarged. The skin over the breast was healthy, and manipulation gave rise to some pain; no fluctuation could be felt in the swelling. The diagnosis of the case was obscure. A month later it came out that the woman was pregnant about three months. The tumor then enlarged, and was indistinctly fluctuating; an exploratory puncture was consequently made into the swelling, and, as pus escaped, this was followed up by a free incision; a good recovery ensued.

CASE X.—Chronic abscess involving the whole breast, with retracted nipple; incision; recovery:

Eliza W., aged 34, came under my care on June 6th, 1867, with a general infiltration and enlargement of her right breast, of nine months' duration. The nipple was completely retracted, and the skin over the breast seemed to be fixed to the gland beneath; to the eye the skin looked natural. The tumor indistinctly fluctuated. The swelling was said to have followed a blow. This woman had been confined in October, 1865, and was suckling in September, 1866, when she received the blow. Tonics were given. Later on, fluctuation having become distinct, an incision was made into the centre of the gland, and pus evacuated, after which recovery took place.

CASE XI.—Abscess in an inactive breast, with retracted nipple; simulating cancer; cured:

Ellen D., aged 39, a married woman, the mother of three children, the youngest being eight years of age, came under

my care on April 1st, 1867, with a swelling in the axillary lobe of her left breast, and a retracted nipple; the base of the nipple being drawn toward the axilla. The swelling had been gradually coming for three or four months without any known cause, and was the seat of a sharp pain. It was vaguely globular and doubtfully elastic. The axillary glands were sound. Its true nature was uncertain, and for diagnostic purposes an incision was suggested, but consent for this was not obtained. In two weeks the skin had become glued to the parts beneath, and some slight redness appeared; an incision was consequently made into the breast, and some ounces of pus evacuated. In three weeks the patient was well.

CASE XII.—Chronic enlargement of the breast with retracted nipple, simulating cancer, chronic abscess (?), excision; cure:

Mrs. W., aged 64, consulted me in November, 1875, for some enlargement of her right breast, which had been coming on for about four months. The nipple was retracted, but this condition was said to have been congenital. There had been but little pain in the breast during its enlargement. When I saw her the breast was generally enlarged and indurated. The nipple was completely retracted. The skin over the breast was natural, and there were no enlarged axillary glands. I regarded the case as one of carcinoma, and advised excision. The operation was performed, and a rapid recovery ensued. The patient, now nearly twelve years after the operation, is quite well. On making a section of the gland through the nipple after its removal, a quantity of yellow purulent fluid escaped and scattered itself over everything. It had been ejected from a cystic cavity, which occupied the centre of the gland, and the walls of the cavity looked as if they had broken down. With the naked eye examination I was in doubt as to the cavity being caused by a softened cancerous tumor, or to an abscess. Dr. Goodhart consequently examined the growth, and reported as follows:

"I have examined the breast tumor you sent to me. Without venturing to be too positive, I think it is only inflammatory; at any rate, all the appearances met with are explicable on that hypothesis. The breast tissue is still quite distinct and healthy looking, but in places a large number of granulation-like cells are found crowded into the fibrous tissue, nor-

mal to the part. There is no variety of shape, and no excess or easy displacement (milky juice) of cellular elements. Outside the breast tissue proper the fat is undergoing definite change, not that of infiltration, but of absorption of oil, and crystallization of margarine, etc., leaving behind cells which at first look suspicious from their size, but which, I believe, are nothing more than fat cells gone into training, and having disposed of their superfluous oil.

"The naked eye appearances are quite those of a chronic inflammatory tumor; healthy breast swollen out, in fact, not infiltrated.

"I shall be glad to know any result that may hereafter declare itself, and in the mean time shall believe that it will not recur."

CASE XIII.—Tumor in the breast of a married prolific woman, twelve years supposed to have been a cancer, which suppurated and was cured:

In March, 1860, a married woman, aged 40, the mother of six children, whom she had suckled, the youngest being eight months, was admitted into Guy's Hospital under the care of the late Mr. Hilton, with a tumor the size of an egg in her right breast, which had been steadily growing for twelve years. It was clearly in the gland, irregularly nodular and hard. The skin over it was glued to the tumor beneath. The nipple was natural, axillary glands free. The tumor first appeared twelve years before, when the woman was twenty-eight, and had increased after each confinement and period of lactation. It was supposed to have been carcinoma. While under observation, however, it inflamed, and discharged healthy pus. A free incision was subsequently made into it, and a rapid recovery followed. This tumor could hardly have been an inflammatory one from the first. It might have been at the beginning a galactocele or cyst which subsequently suppurated. When the notes of the case were taken by me in 1860, no reasonable explanation of the case could be found.

These cases, which are well worth studying, and on that account have been reported, are enough to indicate the different courses a chronic abscess may take; the different symptoms to which it may give rise; the difficulties that may be experienced in forming a true diagnosis; and lastly, the errors of treatment that may be made.

[illegible] are enough to teach the surgeon the necessity of caution both in forming an opinion, and in dealing with the case when the diagnosis is not sure. They indicate the propriety of making an exploratory puncture or incision into any tumor whenever there may be the slightest doubt as to its nature, a lesson which the consideration of tumors themselves will help to enforce.

Inflammation and Suppuration of the Male Breast.—The male breast may inflame and suppurate in the same way as the breast has been described as doing in the female, although examples are not common. Injury may, in some cases, be the cause, but in others no definite history of such can be obtained. Indeed, in the male as in the female, inflammation may apparently originate apart from anything of that nature. I find, however, from my notes of twelve cases, that the affection in eight was attributed to local pressure or injury. At puberty a boy's breast may fill up, and become as tender and irritable as a girl's; and then, either by treatment or without, get well, and no longer be a source of trouble. During young adult life the same affection may occur.

In other cases the inflammation may follow the congestive stage, which probably best expresses the condition of the breast called irritable, and this inflammation may end in suppuration. I have seen several examples of this.

All these cases are to be diagnosed and treated in the same way as when they occur in women.

The following brief notes of some of the cases which have passed under my care will probably best illustrate the whole subject. Many I reported in 1868.[8]

Case I.—Irritable breasts in a boy:—

Timothy W., aged 15, a compositor, came under my care in 1865, with swollen, congested, tender, and painful breasts. Both glands were alike, and the symptoms had been coming on for months. The boy's health was good, and no history of injury could be obtained. Fomentations locally were ordered, and tonics prescribed. In one month the boy was well.

Case II.—Chronic inflammation of both breasts in a man; retracted nipple:

George W., aged 31, came to me on January 19th, 1866, with an inflammatory induration of both breasts, enlargement of

the glands in the left axilla, and retraction of the left nipple. The affection had been coming on for six weeks without any assignable cause. Under the use of the extract of belladonna applied locally, and tonics, the pain became less, and in six weeks the left breast returned to its natural size. The right breast was more obstinate, but ultimately recovered with a retracted nipple.

CASE III.—Abscess of the breast after injury:

W. H., a lighterman, aged 31, came under my care on June 23d, 1862, for some affection of both breasts. It had been coming on for one week, and when seen, both glands were enlarged, tender, and painful. He believes he struck his left breast with an oar three days previously. Fluctuation was detected in the left gland, and consequently an exploratory puncture was made from which pus escaped. The wound was then enlarged, and the abscess cavity irrigated and drained. Tonics were given, and in two weeks the man was well.

CASE IV.—Large abscess in male breast; recovery:

Joseph K., aged 21, a healthy smith, came under my care on January 3d, 1858, with an abscess in the right breast, the size of a large orange. It had been coming for two weeks, and had given rise to much pain. No assignable cause was given for its origin. Fluctuation was readily detected in the tumor, which was deeply placed in the gland. The skin over the gland was healthy. A free incision was made into the abscess at its lower and outer surface, and several ounces of pus evacuated. In three weeks, with tonics, he was well.

CHAPTER VI.

HOW TO EXAMINE A BREAST—FUNCTIONAL DISORDERS OF THE BREAST.

The Examination of a Breast.—In examining a breast with diagnostic intentions, the whole gland should be well in view, and the patient should be either lying down (the most desirable position) or reclining well back in an easy chair. The hand, made warm, if necessary, by dipping it into warm water, should then be placed flat, with its palmar surface upon the breast, and the gland manipulated gently with fingers and thumb in every part. By these means, if an isolated tumor be present, or any local infiltration of the breast or of one of its lobes exists, its presence will be detected; for a tumor growing in the breast, or infiltrating it, would at once manifest its presence to the touch as a decided projection forward. The surgeon should not grasp the breast between his finger and thumb, or raise it by his grasp from the pectoral muscle, until the former examination of the gland has been completed; for in such an affection as the irritable mamma, the gland by such a method of examination would feel like either a round or flat tumor beneath the skin, under which circumstances the idea of tumor would be excited in the surgeon's mind, whereas when the whole gland is pressed flatly against the chest, with the palmar surface of the surgeon's fingers, no such apparent tumor or hard infiltrating mass will be perceptible. Under these local circumstances, and with the other general symptoms to which attention will be drawn, the diagnosis of this affection can usually be correctly made.

Irritable Mamma and Chronic Thickening of the Breast.—By an irritable breast is meant a gland which is hypersensitive, the skin as a rule sharing this increased sensibility. The breast, at the time when the pain is present, is also usually full; that is, when compared with the unaffected gland, it is larger, firmer to the touch, and the skin covering

it is more vascular, as indicated either by redness from engorged capillaries, or by filled veins. The pain varies in different cases, and at different times in the same case. It may be so severe as to make the patient dread the slightest touch, even of her dress; and the examination of the breast by the surgeon may induce either a general suffusion of the patient's face and neck, or give a shock to her circulatory system, so as to bring about almost a state of fainting, as indicated by sudden pallor, nausea, and a feeble pulse. The pain is not always only local, it spreads in some cases up the neck, round the side, or down the back or arm.

Pressure upon the middle or anterior branches of the intercostal nerves, as they pass through the intercostal muscles to supply the gland, excites severe distress, and it may be noticed that now one, now another, branch will be involved. The seat of pain in the breast itself always corresponds to the branch of nerve affected. The pain is usually paroxysmal, and it may at one time affect a single breast, and at another both; or it may leave one and attack the other, and these alternations may even occur in the course of a day.

This hyperæsthesia is more common in its extreme form in young girls and single women under twenty-five years of age, than in others of a maturer age; while the thickening of the gland, and minor degrees of increased sensibility occur more frequently in single middle-aged, or married sterile women from twenty-five to forty-five years of age. In every case of either young or middle-aged subjects, some derangement of the functions of the generative organs will be discovered on investigation, and the catamenia will be either profuse, painful, irregular, or absent. There will probably be some leucorrhœal discharge between the periods. With this disordered condition of the generative organs, the other functions of the body will be generally out of order, and the nervous system will be excitable from pain and want of rest. This local affection is never associated with any of the usual external indications of what is called inflammation. The skin, if more full of blood, is never red as in a local inflammation; and the temperature of the breast or body is not elevated. No tumor, moreover, is ever felt in the affected breast when the hand is placed flat upon it. The diagnosis of this trouble should consequently in young women never be difficult. In women be-

tween thirty and forty-five years of age, where the nerve element is less and the changes in the breast more marked, difficulties of diagnosis may be experienced. Indeed, a surgeon in even moderate practice is not likely to pass many weeks without being consulted by a patient who has this affection, who thinks, or has been led to think, that she is the victim of some cancerous or other growth.

Treatment.—This affection requires general as well as local treatment, since in the majority of cases it is secondary to general causes. What irregularities connected with the catamenia exist should consequently be attended to, and should there be any suspicion of indulgence in depraved habits, means must be adopted to correct them. General means to improve the bodily health of the patient are always called for, and mild aperients, to keep the bowels open; tonics are, as a rule, useful, quinine or bark and iron being the best; where pain is a real source of trouble, sedatives may be combined with the tonic. Plenty of good air and gentle exercise should be prescribed.

The local treatment resolves itself into protecting the breast from manipulation and injury, by covering it up with a belladonna plaster, or belladonna as an ointment fixed on with strapping, so as to support the breast. When pressure such as this cannot be tolerated, the local application of belladonna ointment and cotton wool should be tried. In exceptional cases the warm lead and opium lotion gives relief; or when an attack of pain occurs, the application of a piece of spongio-piline, upon which a solution of opium has been poured, is likely to give great relief.

Functional Disorders of the Mamma.—The function of the breast is to supply milk for the newly born infant; and in girlhood the gland develops up to a certain point *pari passu* with the pelvic genital organs. But though growth may continue, it is probable that development does not much advance until the time has come when girlhood passes into womanhood. When this period of life has been attained, the breast gland, with the genital organs, undergoes further, although still not yet complete, development, since absolute ripeness waits on pregnancy. As soon as this event occurs the breast may be truly said to take the last step in the way of preparation for its perfected functions, so that it may be ready when the full

period of pregnancy has been reached to do the work for which it was intended.

The development of the gland, however, although it is in a sense intermittent as regards its pace, is carried out on the same lines as were laid down for its physiological progress even in the embryo; so that when the breast passes on from that of girlhood into that of womanhood, it does so simply more rapidly than it did before; and when, under the stimulus of pregnancy, the process of development goes on up to its stage of perfection there is still but one continuous process of evolution.

"The continuous and useful production of milk," says Creighton in his suggestive work on the breast, "which alone constitutes the function from the physiologist's point of view, is not the essential or primary activity of the organ, but a mere prolongation of its evolutionary force at its highest point."

This evolutionary force may at times act irregularly and oddly, and then there comes disease. At one time, even when the gland's true physiological function is naturally called for, there is no response, and a more or less true want of milk secretion (agalactia) is met with. Under other circumstances the secretion may be so excessive, that it either flows away (galactorrhœa) or the breast becomes so congested with its own secretion as to give rise to serious trouble, to which attention has been already drawn. In rarer cases, the breast of a girl, before womanhood, so far as the pelvic genital organs and general physical development are concerned, may actually secrete milk, as may the breasts of unmarried women. Indeed, cases have been recorded in which the breasts of old women have secreted what has been described as milk, and still rarer ones where the breasts of men have been said to have done the same.

These anomalous cases need not claim much attention in a practical work such as this. References to works where they may be found will be given on another page.

Agalactia.—When a want of secretion exists, the fault may be either in the gland itself or due to some fault in the general economy. When in the gland itself, there may be some organic imperfection in its development, as shown by smallness in size; some wasting of the gland structure after either

an attack of inflammation and suppuration, or some prolonged antecedent lactation; this latter cause, as it were, so exhausting the secretory power of the gland as to cause its atrophy.

On the other hand, the breast may be a large one, and the subject of what is called hypertrophy, though wrongly, and yet secrete no milk. (See Hypertrophy.)

Occasionally the pressure of new growths in the gland induces atrophy, but such a result is not common; for breasts, the seat of cancer, sarcoma, and adenoma, often secrete freely. When the cause of want of milk secretion is due to general and not local conditions, it is from deficiency of constitutional power, temporary or permanent, brought about by either functional or organic disease.

Occasionally the administration of large doses of iodine or of potassium iodide have been said to produce wasting and agalactia; I cannot confirm this observation from my own experience.

At times the breast gland may be healthy, and yet not quite prepared for suckling when delivery has been accomplished, some delay in the appearance of the secretion from some local or general reason having taken place. Under these circumstances time may work wonders when the functional activity of the gland is stimulated by the child being put to the nipple, and by the application of hot fomentations to the gland.

When the secretion of the gland is evidently scanty, the child should be weaned at once, for its own as well as its mother's sake.

Galactorrhœa, or the constant flowing away of milk secretion from one or both breasts, either during suckling or after weaning, is a troublesome affection. In some cases the flow is doubtless excessive, in others such a term is hardly applicable, since the discharge of a pint or a pint and a half of milk a day may be the quantity lost, and such is probably no more than the normal quantity of secretion in an active breast. On the other hand, cases have been reported in which the flow was enough, as Dr. Matthews Duncan states, to run through the bed and over it to the extent of many pints a day.[9] It may occur in healthy rich-blooded young women from oversecretion, the unused organ overflowing, as it were, while the

other is being suckled, the milk secretion being of a good character; or, it may occur in feeble women in whom the milk secretion is over-thin, such patients being bad nurses.

It may affect both or only one breast, the rule being that both glands are involved. That galactorrhœa should at times be unilateral, is no more curious than that after pregnancy milk secretion should be unilateral. The cause of the trouble is difficult to fathom; indeed, no satisfactory cause has been assigned. It is probably due to some deficiency in the inhibitory force of the nerve supply. That it has a close connection with the uterine condition there is little doubt, since it as a rule soon ceases when the catamenial functions become re-established.

Treatment.—The chief object of the surgeon in the treatment of these cases is to bring about the re-establishment of the catamenia, and improve the general health of the patient. The administration of iron in full doses is therefore indicated even to affect the uterus, and hot footbaths to act as derivatives should also be employed. Arsenic, quinine, iron, strychnine, and belladonna have all had their advocates, but in no one of these drugs can any great confidence be placed: still, all are good in individual cases. Saline aperients are doubtless valuable, and also some restriction in the amount of liquid food. Belladonna applied locally, with the pressure of a bandage or strapping, is undoubtedly of use; and pressure alone has its value. Opium given in half-grain doses two or three times a day combined with quinine or iron, acts occasionally like a charm. Birkett advises the use of iodine with or without iron as medicine. Iodine has been advocated for years, but I have failed to witness its benefits.

CHAPTER VII.

SCROFULOUS SWELLING (INFLAMMATION) OF THE BREAST.

I HAVE adopted as a heading to this chapter a term applied by Sir A. Cooper more than forty years ago to a class of breast cases which be believed originated "in a low form of inflammation to which the term scrofulous may be applied," and which in more recent times is believed to have its origin in the deposition of tubercle. For many years this affection has not been recognized as a special one, and it has doubtless been mixed up with chronic inflammation and chronic abscesses. How far a distinction should be made between these affections, time and experience will determine: but I think it well to make the subject a distinct one in such a clinical work as the present professes to be.

Sir A. Cooper drew attention to it in the following words: "In young women," he wrote,[10] "who have enlargement of the cervical absorbent glands, I have sometimes, though rarely, seen tumors of a scrofulous nature form in their bosoms, confined, in most cases, to a single tumor in one breast; but in one case two existed in one breast, and one in the other. They are entirely unattended with pain, are distinctly circumscribed, are very smooth on their surfaces, and scarcely tender on pressure. They are very indolent, and vary with the state of the constitution, diminishing as it improves, and increasing as the general health is deteriorating. They produce no dangerous effects, and do not degenerate into malignancy. They do not require an operation; and indeed, is would not be justifiable to remove them by the knife. But I have seen them removed, from an error in judgment respecting their nature, and when cut into, after their extirpation, they are found to be composed of a loose and curdy fibrin, very unequally organized."

Velpeau, in his work on the Breast (1853), as translated by Henry (p. 110), writes, "Though possibly here, as in every other situation, tuberculous abscesses of the breast are, notwithstanding, rare;" "the breast is sometimes the seat of abscesses which may be called tuberculous, because of the progress, and especially of the character of the pus which they contain." He then quotes an example in a woman, aged 40, which he believed to be tuberculous, but which would probably by most surgeons have passed as one of an ordinary chronic kind. Later on (p. 223), he states that "tuberculous tumors, without general tuberculosis, may chance to occur in the breast. They are usually single, and have no fixed sign or form. Lumpy and irregular in shape, they may present themselves in the centre of the gland, first, as under the skin, but more commonly they become developed beneath the mamma. Supervening in consequence of a blow, or without evident cause, they sometimes progress very slowly and indolently, and at others, more rapidly, and accompanied by sub-inflammatory symptoms. They are composed of hypertrophied, lardaceous, grayish tissue, of a sort of cyst, which is very thick in some points, and very thin in others; the loculi of which contain either grayish flocculent pus or free albuminous clots, or caseous or thick tuberculous matter, adherent to or combined with the neighboring tissues; sometimes, however, they are represented by homogeneous masses, which are solid though friable, and which by their form simulate pretty closely encephaloid or colloid masses."

Velpeau then quotes a couple of cases, one in a woman, aged 30, and another in a girl, aged 19, in whom indolent, lumpy, movable tumors, situated in a lobule of the gland, appeared; one was excised, and found to be of the nature described; the second was treated by incision and was cured. In the former, lung disease co-existed, and after the removal of one breast, tumors like those in the excised gland appeared in the other. Velpeau also pointed out that this breast affection is frequently associated with some deep-seated thoracic disease; under such circumstances, the breast trouble is a consecutive one, and needs no discussion. When it appears as a local affection, these tumors are slow in their progress, and rarely attain any size larger than a walnut. They make their appearance as often as not without any known cause,

but occasionally after injury: they are frequently multiple. They occur in delicate lax young women under 35, who suffer from catamenial irregularity, and are at times the seat of pain of a lancinating character: usually this is very slight, and the pain is intermittent.

Dr. Léger writes on the same subject, and reports[11] a case of a pale, anæmic, single lady, aged 30, who, seven months before consultation, discovered an indurated lump the size of a filbert at the lower part of her right breast. This nodule steadily increased in size, and when seen was knotted, subdivided into lumps, and at the same time painful. The skin over the lump was slightly adherent and of a violet color. The nipple was somewhat retracted; axillary glands free from enlargement. The lady had chest symptoms and night sweats, and she died from phthisis.

Billroth reports a case which he described as one of chronic caseous matter, producing mastitis, in a scrofulous girl, who was brought to him with nodules containing caseous matter, varying in size from a hazel to a walnut, in her breast. Each one was incised, and then cauterized with nitrate of silver with a good result.

Richet describes[12] a case, in which, at the outer part of a breast, a tumor the size of a turkey's egg existed, made up of three parts, which was elastic, and hard; pus flowed from two incisions which had been made into it. When pressure was made upon the tumor, pus no longer flowed, but there exuded a sort of plastic lymph, yellowish, stringy, not resembling the fœtid discharge of cancerous tumors, but recalling rather the appearance of thickened lymph. Richet adds, that tuberculous or caseous tumors of the breast, alone, have the characteristics as above described. Other cases of this affection are on record, and I am sure I have seen some, but have failed to recognize them at the time as I ought. My attention was drawn to the subject by an able paper published in Gaillard's "Medical Journal of New York," June, 1884, and written by Dr. G. Durant of New York, who after a careful review of the whole subject, sums up as follows:

From a clinical point of view, tubercles of the breast present two varieties, perfectly distinct from each other: (1) a disseminated form; and (2) a confluent form. In either, the onset is insidious; the tubercular matter is developed slowly,

and without producing pain, and some time elapses, usually, before the patient becomes aware of any trouble in the breast. Sometimes, but very rarely, even at this period, one or more enlarged lymphatic glands, under the inferior border of the pectoralis major, may be found. They vary in size from that of an almond to that of a hen's egg; they suppurate, and a fistula remains, from which a serous pus, containing caseous clots, exudes. These openings, after existing for several months, may seemingly heal, but with the progress of the disease in the substance of the gland they reopen and again discharge.

In the *disseminated form* either there is no increase in the volume of the breast, or it is so slight as not to attract attention. The skin is not adherent to the anterior surface of the breast, the nipple retains its usual pouting form, and the mamma moves readily on the underlying tissues. Careful palpation detects hard masses in the substance of the gland. These are disconnected, variable in number, and the size seemingly inversely as their number. Usually they have the size of an almond, but may attain to that of a walnut. They have but little mobility, seeming to be connected with the adjacent tissues. Their surface is roughened by granulations, their consistence is firm, though not cartilaginous. Seldom do they give rise to pain. They develop very slowly, and often after they reach a certain size the growth ceases. In one case no increase in volume could be perceived, though four years had elapsed between the examinations. The termination of this form is unknown. Dubar[18] says that he is unable, from his researches, to say whether they may disappear spontaneously in whole or in part; or whether, a subacute abscess being formed, they may thus be eliminated.

The Confluent Form.—While the disseminated form may remain latent during the lifetime of the patient, and only be recognized at the autopsy, this is not true of the other variety. The tubercles by their agglomeration and fusion constitute tumors, which, on account of their increasing volume, cannot long remain hidden. The breast may in a few days double in volume from a sprouting out of one or more of these nodules. All these changes may take place without inflammation and without pain; while in other cases, febrile symptoms, gastric disturbances, and severe pain, press hard upon a sick one.

The pain may be continuous and lancinating, or it may continue several days, then disappear, then return anew. Palpation tells us that the growth is not equally distributed throughout the organ. It is confined to one portion of the gland, and here an ovoid body of uneven surface and variable size may be circumscribed. Almost unmovable in the substance of the gland itself, with which it seems connected, the tumor does not appear to send prolongations backward. It is unyielding to the touch, and yet, by fixing the mamma by one hand, a sensation of fluctuation may be perceived. In that portion of a gland where the new growth is not so well developed, only a diffused swelling exists. The lobulation of the gland can with difficulty be recognized: the skin is normal, is readily moved over the anterior surface of the organ, which itself is not abnormally adherent to the deeper parts. Should a puncture or incision be made into one of the fluctuating points, a varying quantity of a purulent liquid, containing caseous clots, will escape, and the volume of the breast will diminish. After a varying time (a month and a half in one case) the fistulous openings close and a slight puffiness alone remains. Sooner or later, however, the swelling reappears, and a new incision is made, or an opening appears, which remains permanently. When the fistulæ are well established, the disease has reached its full development, and the appearance of the gland is characteristic. In that part of the breast greatest in size a well-defined tumor exists, and on a level with it one or more fistulous openings. At the anterior wall of the axilla, fistulæ with fungous ridges are found in the centres of circumscribed tumefactions. The skin around these openings is a dusky red, and for a slight distance is adherent to the subjacent parts. The nipple may be retracted should the fistulous opening be in its neighborhood. Behind the fistula, palpation reveals more or less extensive induration. At the axilla the fistulæ are not deep, while in the mamma the probe may penetrate from one to two inches. The exploration is not painful, nor does noticeable bleeding follow. The tissue exposed through the opening is found to be very soft and friable. One would suppose that this ever-extending, though slow growth, would sooner or later destroy the whole organ. It is not impossible, however, that a portion of the breast may be spared. The termination of tuberculosis of the

mamma by natural process is unknown. Probably a deposit in some other organ, as the lung, terminates the scene.

Dr. Durant draws the following conclusions:

(1) That the breasts may be the seat of tumors similar to the pathological products found in many other organs, to which the name of tubercle is given. (2) Tubercle in the mammary gland is much more common than is generally supposed. (3) That mistakes as to the true nature of these growths have often been made, and ablation of the breast, from a belief in their cancerous nature, has often resulted. (4) That during life we may by clinical observation distinguish them from other tumors. (5) That as no absolute necessity for the ablation of these tumors exists, we should refrain from operating, unless unequivocal signs of malignancy develop.

With all these conclusions, except the last, I am disposed to agree, but would suggest that in the well-marked examples of this affection it would be well to remove the gland, as by Dr. Durant's showing "the termination of tuberculosis of the mamma without intervention is unknown," and all pathologists are now convinced that persistent suppuration in any tubercular disease is prone to prove a centre for general infection, and that as a consequence the sooner it is removed the better.

CHAPTER VIII.

SYPHILITIC MASTITIS.

THIS affection is one which should be recognized, although it is far from common. I have seen but few examples of it. Why it should be so rare may be difficult to explain; it is probable that such cases have been mistaken for and treated as examples of cancer. Neither John Hunter, Sir A. Cooper, Brodie, Birkett, nor Gross, mention the affection. Lancereaux, in his treatise on Syphilis, tells us that the celebrated Sauvages[14] gave an excellent example of it. The case occurred in an unmarried woman, aged 30, who had been using, for several months, the extract of hyoscyamus. She presented, in each breast, a tumor the size of a hen's egg. Dense and knobby, this tumor caused lancinating pains, which extended at times as far as the axillary region, along a chain of glands equally hard and knobby. The patient had ulcers in the mouth and vagina, resulting from syphilis acquired ten years before. Keyser's pills, continued for a month, caused the disappearance of the painful tumors, and other syphilitic manifestations, which did not return.

Richet[15] says, "This tumor presents itself at first with all the characters of a scirrhous tumor, and I confess that in a case observed at the Lourcine Hospital, extirpation was on the point of being performed when the discovery of another tumor, if not similar, at least analogous, in the calf of the leg, induced us to wait. The simultaneous disappearance of these two tumors under an appropriate treatment completely removed all doubt."

Ambrosoli[16] relates three cases, one in a male, two in young women, aged 19 and 24 respectively. Both of the latter presented, soon after the disappearance of syphilitic exanthema, a diffused, firm, somewhat painful swelling of the breast, without change of color of the skin. This swelling being associated

with induration of the axillary glands, iodide of potassium, in large doses, effected the removal of these symptoms without leaving any trace of their existence. "I have," said Lancereaux, in quoting this case, "seen a very similar one."

Velpeau, in his work on "Diseases of the Breast," as translated by Henry, 1853, mentions four cases, as observed by Maisonneuve, and one by Richet. One was a simple gummy tumor. In three others there was at the same time ulceration of the skin over the tumor, and circumscribed congestion of the mammary gland. In all, there existed at the same time other syphilitic manifestations, such as gummatous tumors on the head, ulcers on the legs. The cure in all was rapidly brought about by preparations of iodine.

Studied in both sexes, syphilitic lesions of the breast differ in no way from those of other organs; they are most analogous to those of the testicle. They are essentially gummatous infiltrations of the connective tissue, covering the breast, behind it, or in one or more of its lobules. In exceptional cases the whole gland may be involved.

The disease, where it attacks the subcutaneous tissue over the gland, will show itself as an ordinary gumma, and run its course in the same way. When it affects a lobe or more of the breast, its clinical symptoms are obscure. It may appear as a more or less defined tumor in one lobe, of which it seems to form a part, and the skin over the tumor will in this stage of the affection be natural. As the lump increases, the same want of other symptoms will be experienced, and the tumor may yet feel hard, and be painless. The skin over it may yet be free. The axillary glands may, however, be enlarged. Should the swelling form in the periphery of the gland, the nipple will be natural; should it do so near the centre of the gland, there may be retraction of the nipple.

As the disease progresses, the tumor will enlarge, and the skin over it will become involved, but as in a chronic inflammation, and not as in a scirrhus; it will become glued first to the parts beneath, then become of a dusky color, later on, red, and last of all ulcerated; not first dimpled, then puckered, and subsequently infiltrated as in cancer. The tumor also, as these superficial changes appear, will become more fleshy, softer, and at last give rise to the feeling of fluctuation.

In this, its last stage, the disease has either partially or

wholly softened down, and may discharge itself as an abscess, or the whole tumor may die as a mass, and slough out as may a bursa, thickened and inflamed by gummatous inflammation.

The progressive softening of a gumma in whatever gland or tissue it may be found, is a characteristic symptom of the affection; for diagnostic purposes it consequently requires emphasis.

This disease, although slow in its progress at first, is more rapid toward its close. It mostly attacks women under thirty, although it may appear in a syphilitic at any time. Bumstead states that it may occur as a result of hereditary syphilis, and I am disposed to agree with him, since I have seen an example of disease of the testicles from this cause, and the two diseases are analogous. It can hardly be mistaken for cancer in its later stages. In its early stages the error may take place. The age of the patient in which it occurs, the presence of other manifestations of syphilis, the clinical history of the case, and above all, the suspicion that the disease may be gummatous, will be the best help in diagnosis.

CASE I.—Gummatous infiltration of breast; sloughing of the whole gland:

Martha C., a married woman, aged 46, who has had no children or miscarriage, came to me on August 12th, 1869, with an infiltration of the upper lobe of her left breast, which had been coming for eight or ten months. The skin over the swelling was natural. She had with this, enlargement of the axillary glands, and a suppurating node over her left frontal bone, which had been coming for six months. There was no pain in the tumor. Tonics, with iodide of potassium, in increasing and full doses, were given with benefit.

On October 25th, 1869, the breast tumor had become bossy, and presented the external features of inflammation, such as heat and redness, with fluctuation. On March 31st the breast had greatly enlarged, and was as large as a cocoanut. The skin over it was ulcerating, and the gland tissue through the opening looked dead, and presented the yellow wash-leather aspect, so characteristic of syphilitic deposit. In September, 1870, the whole mass sloughed out and fell as a putrid mass into a basin, leaving a clean granulating surface. On November 10th the woman was well.

No history of syphilis could be obtained, but the case was doubtless a true gummatous infiltration of the breast, as supported by the presence of the suppurating frontal node.

The prognosis in this affection is favorable so far as the life of the patient is concerned, and probably so as far as the gland itself is considered, should the diagnosis of its true nature be made out in its early stage. A gumma of the breast ought to be as amenable to treatment by the iodides of sodium, potassium, or ammonium, as a gumma of any other part. These drugs should be given in steadily increasing doses, up to a drachm or more a day. In exceptional cases the removal of the breast by operation may be justifiable. I have, however, never been called upon to perform such an operation.

Constitutional treatment in by far the majority of cases may be expected to bring about a cure.

CHAPTER IX.

TUMORS OF THE BREAST.

TUMORS of the breast may rationally be accounted for by following out the functional aberrations of the organ, and in proof of this we may all with advantage study carefully the highly suggestive and valuable work of Dr. Charles Creighton, on the "Physiology and Pathology of the Breast" (1878), who has shown that "the investigation of breast tumors reveals merely the working of the physiological law of healthy mammary activity under altered circumstances; that various degrees of disordered function may result in various kinds of tumors;" and that tumor disease of the breast is "essentially a disorder of function."

The breast, in passing from its "resting" or inactive state to that of full activity, undergoes during the entire period of pregnancy a process of "evolution" which is characterized in its different stages by certain cell changes within its acini, and transport of cells without; and, in the return of the gland to its quiescent condition on the subsidence of lactation, a process of "involution" in which a parallel series of changes acting in an inverse order is to be observed, the functional subsidence of the gland being spread over a shorter period of time than its gradual awakening during pregnancy.

When the functional stimulus of the mamma is acting at its lowest point at the beginning of "evolution" or the ending of "involution," the secretory products are large granular yellow pigmented cells, which are found within the secreting acini, in the connective-tissue spaces outside the secreting structure, and likewise in the lymph sinuses of the subjacent lymphatic glands, these cells being the waste products of a feeble degree of secretory activity; and, if the mammary excitation were always to act at that degree of intensity, the secretion, it may be said, would always be in the form of large granular pigmented cells.

At the next appreciable advance in the intensity of the stimulus, the product formed in the gland may be described somewhat generally as a large granular nuclear cell, which is nothing else than the crude epithelium of the middle period of the breast's unfolding, in which an imperfect secretory force resides.

Coming still nearer to the full excitation, the cellular ingredients are fewer and the mucous production much more abundant; and finally, when the stimulus is at its height, the mucous fluid has given place to a fatty fluid, and whatever cellular elements the secretion contains are the well-known colostrum cells which approach most nearly the perfect secreting cell.

The periodical unfolding of the breasts, which is an obvious accompaniment of each pregnancy, is thus characterized by a progressive series of immature secretory products which necessarily run to waste. The epithelial cells are not transformed into milk till the time of delivery and during the period of suckling following; but the functional action of the breast has been at work all through the pregnancy, and has advanced in intensity just as the secreting structure has advanced in its unfolding. The various stages of unfolding have corresponding secretory products, becoming less and less crude, and as there is a similar series of more rapid but exactly parallel waste products in the upfolding, it is a legitimate inference to ascribe "a special kind of secretory product to a certain degree of intensity of the glandular force."

When the breast gland is disturbed from its resting state by a cause other than pregnancy, and in consequence of some morbid excitation is urged into a kind of evolution process, the steps of its unfolding are less orderly than in the normal evolution, and the "spurious excitation" never carries the gland to the end of its unfolding, or to the perfect degree of its function. And although the morbid excitation may be said to correspond in this intensity to a stage of the normal evolution, there is this fundamental difference, that the corresponding stage of the normal process is transient, giving place to a stronger force, while the morbid process continues indefinitely at the same enfeebled level. As a consequence, the cell that should have been thrown off from the acinus as waste almost as soon as it was formed, remains in the place

of its origin to multiply, and, with its progeny, to infest the glandular structure of the breast either as intra- or extra-acinous accumulations. Indeed, according to Dr. Creighton, it is upon deviations from the physiological track such as these that the existence of a tumor depends.

Thus, "a circumscribed tumor arises at a particular part of the gland where the spurious excitation has advanced to a certain stage of evolution or unfolding; in that particular region, probably a territory defined by the blood-vessels, the functional force has acted at a uniform imperfect level for a length of time, the inevitable cellular waste of the crude secretion has accumulated within the acini or around them, and the foundation of a tumor has been laid.

In the healthy action of the organ there is a provision for the disposal of the very considerable amount of cellular waste material by means of the neighboring lymphatic glands. In passing from the secreting acini and in traversing the stroma of the gland, the waste cells often acquire a spindle form; and although these cells are not always distinguishable from the connective-tissue cells of the part, there is, especially in the bitch, a class of pigmented epithelial cells in which such changes of form and position can be clearly traced. The spindle-shaped waste products are the type of the peri-acinous cell collections in cystic or adeno-sarcoma.

So far as relates to the large nuclear cells, the intra-acinous collections of them correspond to the structure of medullary cancer, and the extra-acinous infiltrations of the same cells are a distinguishing feature of scirrhus. "The distinguishing feature of the less malignant form of tumor is that the spurious functional activity comes nearer in the degree of its intensity to that of the perfect secretory force, the transformation of the epithelium is a more real transformation, and the cellular waste is reduced, in part at least, to the class of fibre-like or crescentic elements that characterize the myxomatous and more benign issues of the tumor process."

"The circumstance that the unknown diseased excitation most commonly befalls the gland when it is in the state of rest is of the first importance in accounting for the formation of a tumor. Whether the disturbance be a mechanical injury, or a sympathy with excitement in the ovaries, or of a more

general emotional nature, it comes upon the breast in its resting state. The breast can react in no other way than by following the somewhat slow process of its normal evolution; without the intermediate stages of unfolding it cannot reach the perfect degree of its functions in which there would be immunity from danger. The intermediate stages are necessarily associated with the formation of crude cellular products; it is at one or other of the intermediate stages that the morbid force delays, and the corresponding cellular secretion of the gland thereupon assumes the character of a formative or tumor process."

"The circumstances of the functional disturbance are never exactly the same in any two cases, consequently the respective modifications of structure, or in other words, the structure of the respective tumors, is never exactly the same."

"It is the climacteric effacement of the breast that gives a peculiar character to the disease in women, and there are well-marked structural differences in the tumors according as they appear before or after that period. Those that develop after the climateric years are perhaps the most common, as they are certainly the most intractable, and they have been the real source of ambiguity in the pathology of the organ. That ambiguity depends upon the circumstance that they occur in an organ which is gradually losing or has lost its characteristic structure." Where the normal itself is vanishing, the departures from the normal are elusive.

It seems probable, therefore, from Dr. Creighton's investigation, that the fibromata, adenomata, sarcomata, myomata, and carcinomata of the breast have their type in a series of progressive changes which the gland undergoes in its physiological evolution. The feebler the intensity of the function, the more cancerous the disease; the higher or more advanced the evolution from the resting state, the more benign the tumor.

Under these circumstances, there is difficulty in making any definite classification of breast tumors; indeed, if we take the pathological anatomy of diseases of the breast, it is practically impossible to adopt any classification that is precise, which does not involve the writer of a systematic monograph on the subject in much repetition.

The breast, it must be remembered, is composed of a skele-

ton of connective tissue and furniture of gland cells, and there is no single class of breast tumors which may not for any individual case (scirrhous carcinoma excepted) show the free participation of both these elements. As one or the other predominates in any individual tumor, so will it be called sarcoma or adenoma, according to the prevailing opinion of the day, although practically all the cases are essentially of the same complex structure. Furthermore, any tumor in a tubular gland must almost of necessity be liable to the formation of cysts; its very structure presupposes it. Thus all tumors of the breast more or less are associated with cysts; some largely so. Neither the presence of a cyst in a breast tumor, nor of many cysts, has, however, much pathological meaning, although in a clinical sense it so happens that in a certain group of breast tumors which are largely and chiefly cystic, the term cysto-sarcoma has been applied. For the great majority of breast tumors it is therefore true that in any one of them there may be, at the same time, connective tissue, gland acini, and the derivative of gland tissue, viz., cysts.

Some, and these chiefly foreign observers, have classed most tumors which are not carcinomatous with the sarcomata, on the ground that histological investigation shows that the connective tissue is the initially aggressive element, but it is probably a sounder and at any rate it is a more universally applicable view to regard the type of breast tumor as a composite one, and therefore it seems expedient to retain the old term adenoma for many of them, since to call all these tumors sarcomata is to place them in a group which prevents one from saying positively that any individual case is free from the risk of recurrence, when clinical experience teaches us in no uncertain way that the solid adeno-sarcomata of young women are for the most part free from any such risk and that a large number of the cystic tumors are equally benign. On the other hand, there is not one of them, be it myxoma, fibroma, or sarcoma, which may not return should it develop under the faulty inhibition of later life. I cannot, therefore, agree, as I should wish to do, with the view of that excellent surgeon, Dr. S. W. Gross, of America, as expressed in his recent work upon the Breast (1880), and draw a fast and clear line between these varieties of tumors; indeed, I would rather, after the fullest consideration of the subject, still prefer to maintain the

word adenoma as indicating the special gland elements in most of the varieties of neoplasm of the breast, adding the word fibroma to the more fibrous form; the compound word, "adeno-fibroma," clearly expressing the pathology of the class of tumors as well as its clinical peculiarities. The word will therefore be thus used in this work. On this matter I will, however, let Gross speak for himself:

"While it is true," he writes, "that hyperplasia of the glandular tissue of the breast may be so excessive as to constitute the tumor known as adenoma, this occurrence is so rare that true adenomata must be ranked among the most infrequent of neoplasms." "In all of the connective-tissue tumors, the lacteal glands, although their epithelium may be in a state of irritation, generally remain passive, and as the growth advances they may disappear to such an extent as to be scarcely, if at all, recognizable. Instead, therefore, of being newly formed and predominant, the secreting elements are really merely accessory or accidental, and represent the remains of old or pre-existing glands, contained, but widely separated, in a fibromatous, sarcomatous, or myxomatous stroma" (p. 304).

I should like, moreover, to add that the diagnosis between any of the varieties of breast tumors not carcinomatous is uncertain and difficult, and whether a tumor is to be called a fibroma, adeno-fibroma, adenoma, or adeno-sarcoma, can only in the majority of cases be determined by a histological examination of the growth after removal. Clinically I would therefore still divide breast tumors into two great classes, the carcinomatous and the non-carcinomatous, dividing the latter large class into the adeno-fibromata, adeno-sarcomata, and cysto-sarcomata.

Under these headings the different tumors will therefore be considered. I shall treat of the carcinomata by themselves, and likewise all the cystic tumors, with or without intracystic growths; the lipomata, chondromata, and colloid tumors receiving their share of attention.

CHAPTER X.

ADENOMATA AND ADENO-FIBROMATA· THE FIBROMATA OF GLANDS (A SARCOMATOUS ENCAPSULED GROWTH).

UNDER the term adenoma without doubt a large variety of tumors of the breast have been grouped, this word having included "sarcomatous tumors" of every variety; the "chronic mammary tumor" of Sir A. Cooper; the "mammary glandular tumor" of Sir J. Paget; the "tumeur adenoide" of Velpeau; the "corps fibreux" of Lebert, and the "adenocele" of Birkett. At the present day this grouping is not recognized; consequently, to place myself in accord with its teaching, I shall in the present volume describe several groups of tumors of the breast.

The "fibromata" and "adenomata" of the breast may, in a pathological point of view, be kept distinct, yet it is not possible clinically to maintain this distinction; since in bedside work it is beyond the power of the surgeon to diagnose with any certainty the one variety of growth from the other; and it is only by a microscopical examination of any individual tumor after its removal that its true pathological position can be made out.

It is well, therefore, to know that such a definite diagnosis is of no practical importance, and that the treatment of these varieties of tumors is the same. Indeed, in a pathological sense there is no great difference between the glandular and connective-tissue groups, since all are made up of connective fibrous tissue, ducts, acini, and the cæcal terminations of the ducts in varying proportions. The growths, as a whole, form a chain, of which the links at one end are composed of fibrous tumors, in which the fibrous elements predominate; and at the other end of adenoid tumors composed of more or less typical glandular elements, and containing even glandular secretion; while the intermediate links represent tumors of a

mixed fibro-adenoid type. A connective-tissue tumor, which in non-glandular structures would be either a fibroma, sarcoma, or myxoma, when found in a gland, which is normally made up of gland structure and connective tissue, becomes mixed up with the glandular elements in very variable degrees, so that in the breast, where these varieties are best seen, we have adeno-fibroma and adeno-sarcoma.

While the special characteristics of the tumor may be determined by the changes which are found in the connective tissue of the gland, the changes in the glandular elements themselves are not to be ignored or passed by as of no significance, since I hold it is due to the presence of these gland elements, and the changes that take place in them in morbid processes, that the pathology of breast tumors differs from the pathology of tumors of the ordinary connective tissue unconnected with the gland structures.

It must be remembered that a gland is a compound structure composed of connective and fibrous tissue, with the special gland element in the form of cell structure. In the breast this gland structure is tubular, with clusters of cæcal acini lined with epithelium appended to the tubes.

The breast glands, moreover, are subject to periodical excitement, and at times to active secretion. Under these circumstances, though in variable degrees, increased nutriment is sent to them, and with it increased physiological force is supplied. Should this force fail to attain its true physiological outlet and secrete milk, or should it from some outside or inward cause be excited at wrong times, and as a morbid condition, it will probably tend to mischief, and in a clinical point of view this mischief will, as a rule, take the shape of a new growth.

When an unnatural or morbid excitation affects any part of the gland, and as a consequence growth appears, the result may be overgrowth of any one or of all the elements of which the gland is composed; under such circumstances the gland as well as the connective-tissue structures will increase, and give rise to either the adeno-fibroma where the fibrous tissue is in excess, to the adeno-sarcoma where the cell structure predominates.

In the early history of gland life, the force which the part has supplied to it, in common with the other regions of the

body, is registered in growth and development. At a particular period, again, in its existence, partly, no doubt, owing to calls that are made upon it and partly, also, to a tendency long inherited to take on a definite action at a definite time, the gland leaves off growth and takes on the capability of secretion, and thus is provided an outlet for its energy. Supposing now that, in the full tide of this developmental activity and high nutrition, a part of its secreting surface becomes shut off, or injured and excited when its dormant power cannot find equilibrium in secretion, what more likely (if, indeed, it be not just what we should expect) than that it should go back to its prior formative processes, and commence again to grow? Is not this physiologically sound? At any rate, presumptive evidence in its favor is afforded by the fact that these adeno-fibromatous, cystic, solid, and adenomatous tumors are most common in young unmarried women; in other words, in those in whom secretion is in a state of nascent activity. Give this no outlet, and new growth will very possibly result; but, more than this, the new growth is likely to be of such a kind as shall be a fair index of developmental tone, and of an otherwise healthy state, viz., a fair substitution for healthy gland structure. That this is true is demonstrated by the fact that in certain adenomatous tumors of the breast, encapsuled as ordinary fibromata, the new structure may secrete the normal secretion of the breast. The two following cases, taken from Mr. Birkett's experience, demonstrate the fact. They have been published in the Guy's Hospital Reports for 1855.

"CASE I.—Adenoma with ducts and secretion:

"E. A. K., a healthy married woman, when 21 years of age, and a few weeks after marriage, in 1850, discovered a small lump in her left breast. It was situated in the axillary region of the organ, and she is quite sure it never entirely dispersed. I saw her for the first time in January, 1852. She gave birth to her first child in January, 1851, which she suckled, and mostly with the affected breast, until October, when the infant died. At the time I saw her she was pregnant with her second child, and the condition of the left breast was as follows: it was very heavy, solid, and I thought I could detect fluctuation. It was about double the size of the right breast, and

the enlargement seemed chiefly in the axillary region of the organ. The external appearance was simply that of inordinate size and fulness, globular, and projecting from the thorax. The nipple was displaced considerably, and although never well developed, took a direction forward, inward toward the middle line of the body, and upward. Scarcely any pain was ever experienced in the part, but only an uncomfortable sensation of weight. Doubtless, the fact of her being in advanced pregnancy gave rise to considerable difficulty in arriving at an accurate diagnostication of the disease, for it was not until after parturition, in April, 1852, that a new growth could be distinctly felt. The second child she suckled some months. A third child was born in December, 1853. This she suckled one month, and then it died. While suckling the second infant, milk abscesses formed consecutively in the left breast, which obliged her during the later months of lactation to suckle with the right gland only. For several months previous to the operation for the removal of the tumor, its nature was very clear. During the later months of suckling, and after weaning, the normal gland being relaxed and flaccid, the firm, solid, new growth could be grasped by the hand, and isolated from the breast. At the same time the skin rolled freely over the tumor, and the lobulated surface of the growth was distinctly traceable beneath it. A very large vein was also seen traversing the surface of the tumor, and during lactation the dimensions of this vein were enormous. It took a course toward the axilla, where it was lost. On the 28th of February, 1854, I removed the tumor by merely dividing the skin over it; the mass being only very loosely connected with the gland, not a lobe of the true breast was cut, but it was left entirely in its normal situation after the tumor which displaced it was detached. The tumor weighed three pounds. Very little hemorrhage followed the incisions; the edges were adjusted by means of plaster, and the wound healed in about a month. The tumor was composed of lobes loosely connected together. Each lobe could be separated into lobules; these again into glandules or acini, which contained the cæcal terminations of the ducts. From these the smaller ducts united to form larger, and they traversed in some places the interlobular spaces. The free end of some of these ducts terminated loosely on the surface of a cyst, which contained a large col-

lection of a soft solid material, resembling thick cream. An analysis of this compound, made by Dr. Odling, afforded the following results:

Fat,	85.31
Water,	11.43
Albuminous matter (casein ?),	1.63
Animal extractive,	.21
Inorganic matter,	.58

"Besides this large collection of cream in a rather thin-walled cyst, there was not far distant from it, of smaller size, another cyst, filled with an almost cretaceous material. The wall of this smaller cyst was firm and rigid, or like a piece of thick parchment.

"CASE II.—The only case, except the last described, in which I have found ducts containing milk, was shown to me by Mr. Nathaniel Ward, who removed it from a patient in the London Hospital. The following are the particulars of the case:

"E. D., an unmarried and healthy girl, when 23 years of age, discovered a lump in her left breast, about three and a half years before she showed it to Mr. Ward. The catamenia did not appear until she was nineteen years of age, then they ceased for nearly a year, and when they again reappeared, the general enlargement of the breast commenced. For a few months before the removal of the tumor, a well-defined and lobed mass, connected with the gland, was perceptible. It was situated behind those lobes of the gland which form its sterno-clavicular quarter; but with care the normal gland tissue could be distinctly detected, independently of the tumor. The lobes of the tumor were clearly visible beneath the skin, and a large vein traversed its surface. It was removed in May, 1855, by Mr. Ward, without any of the breast, and that gentleman sent me a section of the new growth. It was one of the firmest, most dense, and closely-packed, small-lobed tumors, which I have examined. It had an extremely irregular external surface, and between the lobes or in the interlobular spaces, which were united together by loose filamentous tissue, were some large veins. These could be traced into furrows between the irregularities on the surface of the tumor. Ducts were also distinctly seen taking a course directly transverse to the large veins, and apparently disposed upon the surface

of the lobes and between them, without any very definite arrangement. Many of these ducts contained secretion exactly resembling cream. The follicular terminations of the ducts were very perfectly developed, and were very minute, although not so small as those of the normal gland tissue. No juice pervaded the mass, but in some places this creamy secretion of the ducts was easily expressed by the cut surface.

"The mammary glands, the nipple, and areola, were in this instance remarkably characteristic of the virgin state. It is, therefore, a most singular fact that a new growth should possess the function of a normal gland, although somewhat imperfectly, especially when those organs, which the new growth closely resembled, had never been stimulated to the performance of their own peculiar function.

"We shall now take a comparative review of these two very interesting cases: Both the patients were very young women, in good health, when the tumors were first observed. One had been married, and was in the early months of pregnancy when she discovered the tumor. The other was an unmarried woman, and a virgin, when the development of the tumor began. In both cases soon after the observation of the tumor, considerable difficulty arose in diagnosticating the disease; in the first case, on account of the general enlargement of the mammary gland coincident with pregnancy; in the second, because the development of the new growth was accompanied with general enlargement of the entire organ. Until this general enlargement of the organ had subsided, the tumor was not perceptible or distinguishable by touch or sight. When, however, in one case, lactation had produced a rather relaxed state of the breast, and, in the other case, the general excitation of the organ had subsided, then, and not till then, the diagnostication of the disease was comparatively easy.

"These remarks are introduced in order to show the very great caution which should be exercised in pronouncing an opinion upon the nature of almost all diseases of the breast during any active or excited condition of the normal mammary gland. Surprise would perhaps scarcely be excited by the existence of the solid and fatty particles of milk, in the case in which the function of lactation had been performed upon three separate occasions while the tumor was growing.

But the other case demonstrates that even a virgin may have a tumor of this nature developed in the breast, and that the new growth may so closely resemble the normal gland, and be so perfectly well developed, as to secrete the fatty and oily particles of common milk.

"In both these cases the tumors were removed without cutting away the smallest piece of the normal mammary gland, a proceeding highly important in a practical point of view; indeed, in all cases of a like kind, the breast itself should be carefully sought for and preserved. This important fact is alluded to by Sir Benjamin Brodie."

At times these breast growths are composed of loosely connected fibre tissue, with but a small admixture of the glandular elements; the growth would then be called fibro-cellular. The best example of this kind that I have seen I now record. The clinical history of these cases, however, and the chances of complete immunity from future trouble after the removal of the primary growth, are the same as in the most benign tumor.

CASE I.—Fibro-cellular tumor of breast, weighing, on removal, four pounds thirteen ounces. It had commenced during pregnancy, and had grown rapidly during lactation. It was removed, and a good recovery took place, the woman being well fifteen years subsequently.

Louise H., aged 34, a married woman, the mother of five children, came under my care on March 17th, 1868, with a tumor in her left breast, which had been growing for eight months, and had made its appearance during the sixth month of pregnancy. She had been confined when coming under observation five months, and was suckling with the healthy breast, but not with the affected one, although at times milk ran from the nipple. The tumor, during three months, had grown rapidly. When seen the left breast formed a large tumor, which measured twenty-five inches in circumference, and at its base seven inches. It was quite movable over the pectoral muscle, and the skin over it, though stretched, was not adherent. The nipple was flattened out. The surface of the tumor was somewhat nodulated, and the mass felt solid and elastic, but it did not fluctuate. The temperature of the breast

was higher than the healthy gland. The axillary glands were not enlarged. The tumor was excised, and weighed on removal nearly five pounds.[17] "Under the microscope the tumor was found to be composed of fibro-cellular structure in various stages of development. A certain portion was made up of wavy tissue fully formed. A larger portion was composed of elongated cells, and fibre cells splitting up into bundles of wavy tissue, and in this structure a large number of nuclei were observed. In addition to these elements, simple cell structures were observed in various portions of the tumor. These cells were for the most part closely packed together, so that in a section composed chiefly of wavy tissue and fibre cells, here and there an accumulation of simple spherical cells could be seen."[18]

It seems that on rare occasions these growths may appear in infancy; when so, they are not to be expected to show the complete glandular elements of adult life; on the contrary, they show more of elementary structures, such as the fatty and fibrous, with some tubes. In the following example these points are illustrated, the best glandular elements of the case being the presence of tubes.

CASE II.—Lipomatous adeno-fibroma in the breast of a male child ten months old; operation; cure:

Absalom S., aged 10 months, was admitted into Guy's on July 20th, 1874, under the care of my late colleague, Mr. Cooper Forster, with a hard tumor, the size of a walnut, situated above and to the outer side of the left nipple, which moved freely upon the deeper parts, but to which the skin was adherent, but not discolored. The mother had noticed the lump for about four months, and it had grown rapidly. The growth was excised on July 22d, and found to be made up of fat and fibrous tissue, with some imperfectly developed breast tubes. "The tumor showed a number of tubes like breast tubes, and outside them a germinating fibrous stroma, containing oval nuclei" (Goodhart). The child did well.

Macroscopical Appearances of the Adenomata and Adeno-fibromata.—The external physical characters of these growths after removal, as well as the appearances of their surfaces on section, are very variable, and yet in both aspects they possess a strong family likeness.

That is, all are encapsuled, although the capsules may vary much in their density; all are lobulated, some but slightly, others in a very marked bossy way (Plate I., Fig. 1).

All have, on manipulation, a firm and fleshy feel; and they rarely, if ever, are so hard as a scirrhus.

Some of these tumors, although a small minority, are intimately connected with the breast, so that to remove them, a portion of the gland itself will have to be taken away. Others, which form the large majority, are so loosely attached to it, that they may be shelled out, on the division of the capsule which surrounds them. In a few cases the tumor is pedunculated and appears as a kind of outgrowth from the edge or one of the surfaces of the gland.

On section, the cut surface of every variety of these two forms of tumor has a tendency to become convex, and to exude a tenacious mucoid fluid. It has, when fresh, a white, pinkish or red appearance, according to its vascularity, and presents many different forms of lobulation, as well as degrees of density.

In some cases the surface will show either a coarse or fine fibrous structure, and under such circumstances, little or no glandular elements will be found; the tumor belonging to the fibromata: while in others the most striking feature will be that of lobulation. It occasionally happens that these two varieties of tumor are found in the same breast. In examining a series of specimens of this kind, the varieties of forms which the lobules assume is very remarkable. Where the lobules are large, the growth will generally be succulent; when they are small, it will be compact. In the compact form the microscopical structure of the tumor will be that of a fibroma, including in its concentric interlacunar bundles of fibrous tissue the cæcal terminations of the ducts and acini of the gland. In the more succulent forms of growth the tumor will be more or less furrowed and fissured, foliated or dendritic, and ducts in the process of development will be seen mixed with the true glandular elements. In some cases, again, the lobules will be compact, smooth, and apparently homogeneous; while in others, or even in another part of the same tumor, the lobe will be subdivided up, and each small lobule will be apparently, except at its base, free from connective-tissue attachments to the neighboring lobules (Fig. 2). Under these

circumstances, it will present to the eye much the appearance of a coarse papillomatous growth pressed into a capsule, each papilla being composed of the cæcal terminations of gland structure, filled with epithelial cells, and held together by fibrous elements.

Histologically the epithelial elements will be normally arranged (typical) upon their special basement membrane, and although these elements may be found in excess within the acini of the gland structure, they will still possess a kind of regularity in their arrangement.

In carcinoma no such regularity will be observed. The

FIG. 2.—Section of an Adenoma, or Adeno-fibroma of the Breast.

epithelial gland elements will not only have no special relation to the cell wall, but they will be found in as great abundance outside as within the cell, and irregularly placed. In fact, they will be found to be infiltrating the whole structure. The presence of the membrana propria in adenoma, and its absence in carcinoma, differentiates the one disease from the other.

In many of these tumors, rounded cavities or irregularly curved spaces are visible, which contain a mucoid fluid, possibly more or less blood-stained. These spaces are sometimes dilated ducts, containing degenerating epithelium, and sometimes apparently spaces due to the distention caused by the degenerate products of the epithelium of the growth. In certain examples of the solid lobulated adeno-fibroma occupying

one of the lobes of the gland, and associated with it, cysts will be found of all sizes, more or less occupying portions of the gland. The cysts may be present without as well as with intracystic growths, and these growths may be of different dimensions and of different structure.

Such growths will, however, to a certainty approach the adenomata in microscopical structure, and show a very variable amount of connective-tissue elements between the lobules, some being dense, others very loosely connected, indeed, probably floating in the serous fluid of the cavity (duct?) in which it is growing.

The co-existence of these varieties of growths in the same gland, at the same time, raises the question as to the origin of the more solid forms, and suggests the probability that they had originally an intracystic origin, and had filled the cyst. This probability is likewise supported by the clinical fact, that in these cases of solid growth there is occasionally found during their development a serous or sanguineous discharge from the nipple, which can be increased by pressure; and also by the pathological facts that in certain specimens[19] a tube can be introduced into the duct near the nipple, and from it all the cysts composing the mass of cystic and intracystic growths inflated; while in certain cases in which, after removal, fresh growths appear, the first tumor will be of the more solid or fibrous variety; the second in time of age, cystic with loose intracystic growths; and the third like the first,[20] solid: the first and last growths being adeno-fibromata, the second cystic adenoma. The following case of Mr. Birkett's illustrates this point:

CASE I.—Of the alternation of the so-called "chronic mammary" tumor, and the "cysto-sarcoma" in the same individual, and at different periods of life.

A healthy, married, but sterile woman, was first seen by me in June, 1851. She was forty-five years old, strong, and in good health, although lately she had felt weak and sinking, and had become rather thinner. The catamenia were not regular, and at times she had suffered with dysmenorrhœa. Four or five months before her application to me she discovered a lump in her right breast; it had been preceded by a pricking and shooting pain, and these sensations had attracted

her attention to the part. When I saw the tumor it measured about one and a half inches square; it was seated on the surface of the gland, and rather toward its sternal border. It was very firm, movable, lobed, and irregular on its surface, and it seemed quite detached from the tissues of the breast itself. The woman suffered great pain upon gentle manipulation, and even for some time afterward. The nipple was unaffected and the axillary lymphatic glands were quite healthy. She said her sister had died of a cancer in the face. Her general health at this time was a little deranged, her appetite bad, and she complained of weakness. Soothing applications were employed over the tumor, and her general health being improved by the exhibition of medicines, the tumor was removed on the 16th December, 1851, by making a single vertical incision through the integument. No part of the breast itself was removed. The new growth was inclosed in a loosely attached envelope; it consisted of three unequally proportioned lobes, and these of lobules which were all associated together by loose connective tissue, in which the cæcal terminations of the ducts loaded with epithelium were inclosed, constituted the lobules.

The wound healed favorably, although the whole gland was extremely tender and swollen, soon after the operation. During the whole year 1852 the breast was usually painful at the catamenial periods, and there appeared to be considerable local excitement in the organ.

In November, 1853, two years after the first operation, a new growth was discovered near the cicatrix; the whole breast was very painful; and in February, 1854, I removed this second growth, together with the cicatrix and a very little adherent gland tissue. The dissection of this new growth exposed several cysts of variable size, and which were filled with intracystic growths, minutely and finely divided into lobules: these were very loosely united together by connective fibre tissue. In another part was a growth much more resembling in appearance the first growth that I removed; it was firm, lobulated, enveloped in a fibrous capsule, and entirely united into a solid mass by connective fibre tissue. As in the first growth, so in these, the minute elements of gland tissue were distinctly visible when magnified; and although the cæcal terminations of the ducts differed from those of the first growth

in many particulars, yet they were well marked and characteristic.

The wound healed favorably, but during the summer months of 1854 she suffered great pain in the axillary half of the organ; the whole became much swollen and indurated, and resembled the breast of a woman during the later months of pregnancy.

In October, 1854, I discovered a third growth at some distance from the cicatrix, and among the axillary lobes of the gland. This increased rapidly, and was accompanied with general swelling and induration of the breast. I removed the third growth in February, 1855. It was much larger than either of the others, was embedded in the lobes of the breast, and was firm, dense, lobulated, and united together by connective fibre tissue. In this growth the cæcal terminations of gland tissue were distinctly seen.

In July, 1855, the patient was well. The principal facts of the case are as follows: The patient when the first growth was discovered, was 45 years old. The first growth was eleven months old when removed; between the removal of the first growth and the discovery of the second, one year and ten months elapsed; the second growth was three months old when removed; between the removal of the second growth and the discovery of the third, eight months elapsed; the third growth was four months old when removed. All the growths, varying as they did in their external appearances, still exhibited, when carefully and minutely examined, those elements and structures which are found in the mammary gland itself, with the exception of ducts. All, therefore, come under the denomination "adenocele."

The first and last were, however, of the same nature as the tumor termed by Sir A. Cooper, "chronic mammary tumor." The second growth belongs to that class of growths described by many writers under the term "cysto-sarcoma."

This case, therefore, clearly demonstrates, that in one and the same individual, at different times, these new growths may alternate with each other. It likewise shows, that the second growth grew more rapidly than the first, and the third more rapidly than either of the other two; and also, that the interval of time between the development of the second and third growth was much shorter than that between the first

and second. These facts, which repeat themselves in the natural history of recurrent new growths, are now generally recognized.

Such cases as these form as it were connecting links between the more solid varieties of fibromata and fibro-adenomata, and the cystic forms of benign breast disease, to which attention will be drawn in the chapter devoted to the subject of "cystic disease with intracystic growths."

When these fibro-adenomata are undergoing degenerating changes, they will appear to the eye of a yellow color, and by pressure or scraping the cut surface cheesy dead epithelial cells may be made prominent. Under other circumstances, when the growth is undergoing a myxomatous degeneration a section of the growth will present a honeycombed surface, and the hollows of the fibrous structure will be filled with a gelatinous mucoid fluid.

Symptoms.—These benign solid tumors of the breast are usually discovered by accident, the patient's attention being rarely drawn to the part by anything that could be called pain; an uneasy sensation in the breast is the most that is experienced. Such a tumor feels, when discovered, as a hard or fleshy, smooth or lobulated nodule, upon, behind, or within the substance of the breast gland; it is generally very movable, and feels like a loose body in the breast, which may at times be separated from it; but should the growth occupy the centre of the gland or one of its lobes, this separation will not be possible. As it grows, it troubles mainly from mechanical causes, for it maintains its original features throughout; it may develop fresh lobules, or become more rounded in its outline, but it will never do more to surrounding structures than stretch them, or press them aside. The mammary gland itself, when these growths are large, may become atrophied, or pressed away up to one or other side of the new growth, according to the lobule of the breast in which the growth originally appeared. When the tumor is central or approaches that position, the breast will be flattened out over its surface. The nipple is rarely much influenced by the growth, and when so it is from mechanical causes. Thus a tumor occupying the centre of a lobe covered with breast structure will stretch the ducts, draw upon the nipple, and thus cause either an obliquity of its position, or some retraction (Fig. 4, page 179). Should

the tumor be a central one, and press equally in all directions, the nipple will become either flat or retracted; I have seen several examples of this affection in which this latter condition was present.

Very little pain attends the growth of these tumors; indeed, in the majority of cases the only sources of bodily discomfort of which patients complain are due to the mechanical effect of the tumor. The chief distress is mental, viz., the fear of what seems so simple becoming eventually a "cancer," or a source of unknown and severe trouble unless submitted to operation. In exceptional cases pain is, however, experienced. Mr. Birkett mentions the fact that in one case intense suffering was due to the filament of a nerve being included in the new growth; and I have certainly found the breasts of some young women who have these growths as sensitive as the simple and uncomplicated irritable mamma.

The integument covering the growth is very rarely implicated, since it is elastic, and yields kindly under a distention which is slow and steady. Should the growth, however, be rapid, the skin may inflame, and even ulcerate, so as to allow the escape of the tumor's contents. With solid growths such as we are now considering, this result is very rare; I have but once known inflammation to occur from distention in such a case. In cystic disease the complication is more common. These tumors never become fixed to the deeper tissues, and only affect them mechanically by pressure, although, as I have said, they may be found to be adherent to adjacent portions of the breast. They do not as a rule give rise to any lymphatic enlargement, and should they do so, it will probably be from some degenerative or necrotic change which is taking place in the growth, or from some irritating effect the growth is producing on the skin or parts around. When lymphatic enlargement co-exists with a tumor which is believed to be benign, the suspicion of its being otherwise should be raised.

Rapidity of Growth.—The more solid the tumor, the slower its growth; the more succulent and loose the structure, the more rapid its increase. When associated with cysts, a tumor may enlarge rapidly, and this enlargement may be the product of increased effusion, or due to the occurrence of bleeding into the cyst. I have recorded a marked example of the latter cause in the twelfth volume of the Pathological

Society's Transactions. On the other hand, these tumors on rare occasions cease to grow or even diminish in size; when it is probable that the diminution in size is due to the absorption of some of the fluid that bathed the free portion of a pedunculated growth.

I have been quite unable to determine the average rate of increase of these tumors; it is so variable. The fibromata and more solid adeno-fibromata rarely attain any size; one the size of a large walnut may be the product of three or four years' growth, and another three inches across represent the growth of fifteen or more years. The more succulent varieties of the adeno-fibromata, although they are usually larger than the more solid, attain a great size in only rare examples. I have removed one of the compact form from a married woman, aged 30, four inches across, that was said to have grown in as many months. In exceptional cases both the solid and succulent varieties may grow rapidly. The cystic forms, as will be shown later on, may, however, increase up to the weight of many pounds. A tumor that grows rapidly with the clinical features of an adeno-fibroma, and is not cystic, is probably sarcomatous.

Multiplicity of and Recurrent Growths.—It is by no means rare for the breast of a woman to hold two or more of these adeno-fibromatous tumors, and both breasts at times may be equally affected. When more than one exists in the same breast, the tumors are as a rule of the same form and density, but I have on more than one occasion removed from a breast a compact tumor, which would be pathologically described as a fibroma, and at the same time a second tumor of a looser and more succulent kind, made up of glandular elements, to which the term adenoma would be applicable: the former example containing but little, and the latter much, of the glandular structure. In the same way, recurrent growths may vary in individual character, though agreeing in kind; a primary growth may thus be of the compact kind, and the recurrent of the succulent; in Prep. 2299[45] of the Guy's Hospital Museum there are three specimens demonstrating this, the third partaking of the characters of the first.

What has been described as recurrence in any given case may be, in truth, simply the continued growth of a tumor which was overlooked during the first operation on account of

its smallness. I have twice seen a second small fibro-adenoma come into view in the incision for the removal of the first growth, which, had it been undiscovered, would have grown, and been called, though wrongly, a recurrent tumor. Tumors that re-appear a few months after the removal of the first growth should be regarded as growths that had been not discovered. (See pages 123, 124.)

These "adeno-fibromata" are found as a rule in the young and unmarried, and in the apparently healthy and robust; they occur, however, occasionally in the aged. The best example of the kind I have seen was in a single lady, aged 71, and it had been of twelve years' growth. When I saw her it was ulcerating. I consequently removed the whole tumor and gland, with an excellent result. The specimen contains samples of every variety of this class of tumors; some masses representing well the fibroma, others the most typical and marked adenoma, both of the compact and loose forms. The adeno-fibromata are seen in every stage. The more compact form of adeno-fibroma, or fibroma, appears generally in girls about the age of puberty, the gland structure at this age having but just advanced sufficiently far so as to be ready under the natural stimulant of conception for a more complete development. In such subjects, when the breast is the seat of a new growth, the adenomatous element is slight, but the fibrous is in excess. In maturer women, and specially in those who have borne children or nursed (when the procreative organs are active, and the mammary glands are in a state of "developmental perfection") the most perfect example of adenomatous tumor is to be expected, since in these subjects the glands have reached their highest physiological function, and consequently their highest development, and any new growths originating in connective tissue at this period would naturally include the active gland structure, and present a more or less succulent and well-marked adenoma or adeno-fibroma, the gland elements being in excess over the fibrous. They are occasionally met with in men in the proportion of 1 to 277 cases of adeno-fibromata in women, as shown by Mr. W. R. Williams, in an able analysis of 11,100 cases of neoplasms admitted into four large metropolitan hospitals, during periods varying from ten to seventeen years, and ending 1883. In women the majority of these cases begin to grow, or are

first discovered, between the ages of 21 and 30, although, as shown by my table, almost as many begin in younger people, at or after puberty; at later periods of life they less frequently originate, although they may be frequently found to exist in them.

From my notes of 100 cases consecutively observed, seen, and analyzed to make out these points:

27 cases were first discovered between puberty and the age of 20, that is, during the developmental stage of the breast's life.
35 cases appeared between 21 and 30 years of age, or during the period of its functional perfection.
22 cases appeared between 31 and 40, during the period of its maturity.
13 cases appeared during 41 and 50; and
3 cases appeared in women over 50, or during the period of its functional decline.
46 of these cases occurred in single women;
39 in the married and prolific;
15 in the married and sterile.

Single women during their prime are consequently most prone to be attacked by these growths, and the married and prolific are the next; the old maid and the married and sterile woman being comparatively free from these benign tumors.

Cause.—No definite cause can usually be ascribed for the appearance of these growths, although in quite exceptional cases injury has been assigned. I cannot say, however, that I have ever been satisfied with any such explanation, for the tumor has usually been discovered too soon after the supposed cause to render the suggestion probable. As a rule, indeed, these tumors are discovered by chance, some accident or blow having drawn the patient's attention to the part, and thus led to the disclosure of the tumor.

Diagnosis.—This should not be a difficult task in the majority of cases. A fleshy or firm movable lobulated tumor in the breast of a healthy-looking single or married woman under thirty; with a mammary gland, its nipple and skin covering, in other respects apparently healthy; and with a history of the slow and probably painless increase of the new growth, or if painful, only so at intervals, or at the times of the cata-

menial flow, is probably an adeno-fibroma. The more movable it is in the gland, the greater the probability of this diagnosis being correct; the more fixed it is, the greater the chance of the tumor being sarcomatous. Any growth that infiltrates the gland, wholly or in part, must be inflammatory or cancerous. The absence of fluctuation in any part of the tumor, and the absence of a marked lobulated or botryoidal outline, excludes polycystic disease; although in every case of growth believed to be benign found in the breast of a woman over thirty, the suspicion of its being cystic should be entertained. The solid or non-cystic fibro-adenomata grow, as already described, in capsules, and simply expand the tissues in which they are placed; they do not spread, as the cancers do, by either local, lymphatic, or vascular infection, but cause trouble simply mechanically by their presence; they do not give rise to discharge from the nipple, as do many of the cystic tumors, and they are generally found in women who are apparently healthy.

Prognosis.—This is, as a rule, favorable, for when one of these tumors has been removed there is every reason to believe that no return will take place. When a second growth appears soon after the removal of the first, there is good reason to believe that it is but the continued growth of a neoplasm which existed undiscovered at the time of the first operation; for I have on two occasions at least, when an adeno-fibroma was being removed from a breast by an incision through the breast gland, which covered the capsule of the neoplasm, seen exposed a small encapsuled second growth, about the size of a pea, which, if left at that time, would have grown, and appeared as a second or return growth. Second or third growths are, however, met with, but such, as a rule, originate in other lobes than that primarily involved, and cannot consequently be called recurrent, for such a term refers to the reappearance of a neoplasm in the position of some antecedent growth, which I do not believe takes place in one out of a hundred cases. Many of these tumors after a time cease to grow, or do so but very slowly; some without doubt diminish in size, and when diminution takes place, the growth is probably cystic, and the absorption of the fluid about the growth has caused its apparent shrinkage. To this point attention will be drawn later on. (See Shrinkage of Tumors,

page 315.) The more fibrous and glandular, or adenoid, the growth is, the better the prognosis. The more embryonic and cellular the connective-tissue elements (that is, the more the growth approaches an adeno-sarcoma and deviates from an adeno-fibroma) the greater the probability of a return.

Treatment.—As a general rule all these tumors should be removed by excision, since experience tells us that they will continue to grow with variable degrees of rapidity; that a tumor which has taken months or years to attain a certain size may often double itself in as many weeks or months, and that no local treatment by applications and no medicines have the slightest influence in retarding their development or helping their disappearance.

It is not, however, necessary to remove every tumor of this kind as soon as it is discovered, for it may grow so slowly, and be so little in the way, as to render its removal a matter of small urgency; at the same time, such a tumor should be taken away from any woman who is likely to become pregnant, or who is past the age of 35, since with a pregnancy the neoplasm is certain to grow, as it, with the gland itself, will have increase of blood sent to it, and likewise from nerve causes will receive an impulse toward growth; and after the age of 35 adeno-fibromatous growths are more likely to pass on to the adeno-sarcomatous, which are far more dangerous.

The operation itself is neither a difficult nor dangerous one. It usually consists of a clean incision through the overlying tissues into the capsule and then the subsequent enucleation of the growth. The tumor should be well pressed forward by the left hand of the surgeon grasping the tissues deeply on each side of the tumor so as to make it prominent and the tissues over it tense; the incision into the capsule of the growth should always be free, and made in a line radiating from the nipple, as by this incision there is less harm done to the breast structure which surrounds the growth, and the risks of injuring the milk ducts are much diminished. When the capsule has been divided, the growth will probably become partly extruded, and its complete extrusion will be facilitated by the division of any fascia which appears to hold it back, and by introducing the handle of the knife between the capsule and the growth so as to lever it out of its bed. The attachments of the neoplasm to its capsule are at times very slight,

and under these circumstances it is readily enucleated; when the attachments are stronger or broader, they may want division with the knife, and under these conditions some vessels may require to be twisted or otherwise secured.

In exceptional cases the neoplasm is so closely connected with the breast tissue as to necessitate the removal of the lobe of the gland in which it is placed.

All bleeding should be thoroughly arrested before the wound is closed, by the torsion of every vessel of any size, and the temporary introduction into the capsule or cavity of the wound of a sponge wrung out of hot iodine water. Its edges should then be carefully adjusted by means of fine sutures and strapping, and the wound dressed, a provision being carefully made for its drainage for twenty-four hours. A little gentle pressure, applied either through iodoform gauze, salicylate wool, or a soft sponge rendered aseptic with iodoform or boracic acid, and bound on with a bandage, is most useful in checking capillary oozing and venous hemorrhage.

In the majority of these cases the wound heals by quick or primary union; where this wished-for result is not secured, the cavity must be daily washed out with iodine water, or some other antiseptic wash, well drained, and carefully dressed with such antiseptic dressings as are favored by the surgeon.

Breasts, after having been subjected to an operation for the removal of one of these benign neoplasms, are rarely so injured as to prevent their performing their physiological functions when occasion calls. In the larger forms of tumor and of operation this result may ensue; but when the neoplasm is of moderate dimensions it is not to be anticipated.

Should the tumor have been allowed to attain a large size, it may be impossible to separate breast gland from growth; under such circumstances it may be necessary and expedient to excise both. It must, however, be stated that large tumors, even up to seven pounds, may be removed from a gland, and the latter left intact and capable of performing its true functions; and under these circumstances it is the surgeon's duty to attempt to save the gland, even when it may appear hopeless. These principles of practice are clearly applicable to cases met with during the child-bearing period of life. At later periods the object for retaining the breast does not exist, consequently the practice based upon it is not necessary.

To render the scar of the operation as invisible as possible, Gaillard Thomas, of New York,[21] when the tumor is of moderate dimensions, makes his incision in the fold which unites the lower hemisphere of the breast to the thorax, and having dissected the gland from its deep attachments, removes the tumor by an incision made in the under surface of the breast. The wound is then carefully drained and treated, and the subsequent scar is very limited.

It occasionally happens that a breast which has been the seat of an adeno-fibroma becomes, in later years, the subject of a cancer. The secondary neoplasm must be regarded as a new growth altogether, and as having only a very slight connection with the first, that connection being probably the same as exists between a cancer and a scar in other parts.

To more fully illustrate many of the practical points mentioned in these pages, the following brief notes of cases, extracted from my note-book, will be read with interest.

The first case refers to the fact that in making a section of breast tissue to enucleate an adeno-fibromatous growth, a second smaller tumor was exposed.

CASE I.—Adeno-fibroma of breast; excision; second tumor discovered by the incision made to remove the first; removal of second; recovery:

Harriet P., aged 30, single, a servant, came under my care on September 23d, 1874, for tumor in her left breast. It had appeared nine months previously as a small movable lump, which steadily increased. At present it measures three inches by two, is situated below the nipple, is movable, nodulated, and firm. On the 25th an incision was made over the tumor, in a line radiating from the nipple, into its capsule, and the growth enucleated. When this was done, a second tumor was discovered placed deeply in the gland beneath the one that had been removed. This was then enucleated, and a good recovery followed. A precisely similar case to this came under my care in the person of Sarah V., aged 25, in March, 1882.

The second case illustrates a very important point in the life history of an adeno-fibromatous or other tumor; and that is, the enlargement of lymphatic glands, and their subsequent subsidence after the removal of the primary growth. The case is likewise an example of multiple tumors.

CASE II.—Two adeno-fibromata in one breast, with enlarged lymphatic gland; subsidence of latter after removal of tumor:

Sophy S., aged 30, a childless married woman, came to me on May 19th, 1850, with two hard lobulated tumors on the axillary half of the left breast, which had been growing for three years. One was as large as a walnut, the second as a nut. Both moved freely in the breast. There was also an enlarged lymphatic gland in the axilla.

May 28th. The tumors were enucleated through one incision, and were excellent specimens of the adeno-fibromata; the gland elements predominating. The patient made a good recovery after the operation. The enlarged lymphatic gland disappeared. This patient was quite well four years later.

The third case is an example of double tumor in a breast, the tumors being good examples of two of the varieties of adenoma. It shows, moreover, the effects of pregnancy upon the growths, and the value of saving the breast in the operation.

CASE III.—Adenoma of breast, associated with adeno-fibroma, complicated with pregnancy; suckling with the affected gland; operation; recovery:

Frances F., aged 22, came under my care March 15th, 1869, with a large tumor in her left breast of two years' standing, and a smaller one of twelve months'. She was then six months pregnant. During the pregnancy the tumors grew fast, as they did during lactation, which she carried on with the affected breast, after a natural labor, for three months, when she weaned the infant. On November 7th one tumor was as large as a cocoanut, and the second the size of a small orange. The latter tumor was much harder than the former. On January 3d, 1870, I removed the tumors and left the breast intact.

The larger tumor, as seen in Fig. 2, page 111, and Plate I., Fig. 3, was a fine specimen of the looser kind of adenoma. The smaller was more of an adeno-fibroma; the fibrous tissue predominating over the glandular. This patient subsequently suckled with the breast, and was in good health five years after the operation. This patient's sister came to me in 1870 with well-marked so-called hypertrophy of her left breast. The gland was twice the size of the right. She was single, and 21 years of age.

The fourth case illustrates the effects of pregnancy and lactation in the growth of an adenoma.

CASE IV.—Adenoma of eighteen years' growth, with rapid increase during lactation:

Mrs. H., aged 38, a widow, the mother of one child three years old, came under my care on June 12th, 1867, with a large nodular and fairly elastic tumor, the size of a cocoanut, in her left breast. The breast gland could be separated from the tumor without difficulty, and the nipple was natural. The tumor had been growing for eighteen years, slowly for fifteen, but rapidly after her last pregnancy and lactation. She would not consent to have it removed.

The fifth case is full of interest, since it is an example of adeno-fibroma in a woman, aged 62, and was associated with a retracted nipple, a sign which is too readily accepted as an indication of carcinoma. The new growth also was said to have followed an injury.

The sixth case likewise illustrates one of the same points, since the tumor was associated with a retracted nipple. In it, as in the former cases, the growth was placed in the centre of the breast gland.

CASE V.—Adeno-fibroma of the breast in a woman, aged 62, following a blow, associated with retracted nipple:

Dorothy S., aged 62, came under my care on July 23d, 1884, with a hard lobulated tumor occupying the centre of the left breast, associated with a retracted nipple, but no axillary glandular enlargement. The tumor had been growing for eight months, and had followed a blow received upon the part one month previously.

July 30th. The tumor was removed by making a free incision into its capsule, in a line radiating from the nipple. It was encapsuled and turned out with the greatest ease. A good recovery ensued. The tumor was an excellent example of adeno-fibroma.

CASE VI.—Adeno-fibroma of the breast, with retracted nipple, in the daughter of a woman who had carcinoma of the breast:

In 1878 I removed from the left breast of Miss N., a healthy girl, aged 18, an adeno-fibroma of six months' growth, which was placed in the centre of the breast, and gave rise to re-

the tumor be a central one, and press equally in all directions, the nipple will become either flat or retracted; I have seen several examples of this affection in which this latter condition was present.

Very little pain attends the growth of these tumors; indeed, in the majority of cases the only sources of bodily discomfort of which patients complain are due to the mechanical effect of the tumor. The chief distress is mental, viz., the fear of what seems so simple becoming eventually a "cancer," or a source of unknown and severe trouble unless submitted to operation. In exceptional cases pain is, however, experienced. Mr. Birkett mentions the fact that in one case intense suffering was due to the filament of a nerve being included in the new growth; and I have certainly found the breasts of some young women who have these growths as sensitive as the simple and uncomplicated irritable mamma.

The integument covering the growth is very rarely implicated, since it is elastic, and yields kindly under a distention which is slow and steady. Should the growth, however, be rapid, the skin may inflame, and even ulcerate, so as to allow the escape of the tumor's contents. With solid growths such as we are now considering, this result is very rare; I have but once known inflammation to occur from distention in such a case. In cystic disease the complication is more common. These tumors never become fixed to the deeper tissues, and only affect them mechanically by pressure, although, as I have said, they may be found to be adherent to adjacent portions of the breast. They do not as a rule give rise to any lymphatic enlargement, and should they do so, it will probably be from some degenerative or necrotic change which is taking place in the growth, or from some irritating effect the growth is producing on the skin or parts around. When lymphatic enlargement co-exists with a tumor which is believed to be benign, the suspicion of its being otherwise should be raised.

Rapidity of Growth.—The more solid the tumor, the slower its growth; the more succulent and loose the structure, the more rapid its increase. When associated with cysts, a tumor may enlarge rapidly, and this enlargement may be the product of increased effusion, or due to the occurrence of bleeding into the cyst. I have recorded a marked example of the latter cause in the twelfth volume of the Pathological

Society's Transactions. On the other hand, these tumors on rare occasions cease to grow or even diminish in size; when it is probable that the diminution in size is due to the absorption of some of the fluid that bathed the free portion of a pedunculated growth.

I have been quite unable to determine the average rate of increase of these tumors; it is so variable. The fibromata and more solid adeno-fibromata rarely attain any size; one the size of a large walnut may be the product of three or four years' growth, and another three inches across represent the growth of fifteen or more years. The more succulent varieties of the adeno-fibromata, although they are usually larger than the more solid, attain a great size in only rare examples. I have removed one of the compact form from a married woman, aged 30, four inches across, that was said to have grown in as many months. In exceptional cases both the solid and succulent varieties may grow rapidly. The cystic forms, as will be shown later on, may, however, increase up to the weight of many pounds. A tumor that grows rapidly with the clinical features of an adeno-fibroma, and is not cystic, is probably sarcomatous.

Multiplicity of and Recurrent Growths.—It is by no means rare for the breast of a woman to hold two or more of these adeno-fibromatous tumors, and both breasts at times may be equally affected. When more than one exists in the same breast, the tumors are as a rule of the same form and density, but I have on more than one occasion removed from a breast a compact tumor, which would be pathologically described as a fibroma, and at the same time a second tumor of a looser and more succulent kind, made up of glandular elements, to which the term adenoma would be applicable: the former example containing but little, and the latter much, of the glandular structure. In the same way, recurrent growths may vary in individual character, though agreeing in kind; a primary growth may thus be of the compact kind, and the recurrent of the succulent; in Prep. 2299[45] of the Guy's Hospital Museum there are three specimens demonstrating this, the third partaking of the characters of the first.

What has been described as recurrence in any given case may be, in truth, simply the continued growth of a tumor which was overlooked during the first operation on account of

not to a great extent; it dwindled down, however, from twenty-three to fourteen inches. A fourth pregnancy then occurred, when, as before, the tumor increased, and soon attained a measurement of twenty-nine inches, and a weight of nearly twenty pounds. At this time she came under the care of Dr. Ashwell. A natural labor soon followed, and four days after parturition, Dr. Oldham, who was watching the case, reported that the circumference of the tumor had increased two inches and a half, so that it measured thirty and half inches. Four weeks after labor the tumor had decreased five inches; she did not suckle with the breast, although she did with the other; on applying pressure to the breast, a little milk exuded from the nipple. The engraving above represents the appearance of the growth, which was lobulated, soft, and elastic. It measured twenty-nine inches round, and weighed nearly twenty pounds. Dr. Ashwell regarded the disease as one of hypertrophy. In 1843 the patient passed into the hands of Mr. Stanley, who removed the tumor on July 16th, 1843, leaving the normal breast, seen in the figure, on the sternal side of the tumor, unmolested. The tumor then weighed only seven pounds.[22] A further note of this interesting case is found in Guy's Hospital Reports,[23] by Mr. Birkett, who writes: "I have seen this patient several times since the operation. She has given birth to three children, and suckled them with the breast from which the tumor was removed. When I last saw her, which was seven years after the operation, she was in good health, and quite free from any disease. I have, through the kindness of Mr. Stanley and with the assistance of the patient herself, identified the tumor in the museum of the college (Prep. 399) with the woman whose history is recorded by Dr. Ashwell, as given above.

1. Encapsuled Adeno-fibroma.
2. Subcutaneous Abscess.
3. Adeno-sarcoma.
4. Sarcoma.
5. Section of harder Variety.
6. Section of softer Variety.

CHAPTER XI.

ADENO-SARCOMATA.

The Sarcomata of the Breast Gland: an Encapsuled Growth.—Sarcomatous tumors are new growths that originate in connective-tissue structures, and are composed of embryonic connective-tissue elements. The cells are, as a rule, irregularly arranged in an intercellular substance, through which the blood-vessels permeate.

They are probably formed from the connective-tissue cells, and the cells assume sometimes a spindle, sometimes a round, and but rarely a giant shape; the name of the growth being determined by the marked predominance of any one kind of cell elements.

These growths, in only exceptional instances, infiltrate a part, as do the epithelial or carcinomatous, but are more or less encapsuled, the capsule varying considerably in its density, this density being apparently much determined by the rapidity of the tumor's growth (Plate I., Figs. 5 and 6).

The tumors, moreover, vary much in their consistency; some are firm and approach the fibroma in feel and appearance; in such, the fibrous tissue is abundant, and the cell element comparatively small (Plate I., Fig. 5). The cells, moreover, in these firm growths will probably be of the spindle shape, the cells of the connective-tissue growth having developed into fibres, which form bundles, fasciculate, and contain within their meshes undeveloped spindle cells. These growths form the "spindle-celled" group of sarcoma, which have been described by the older writers as the "fibro-plastic," or recurrent fibroid, and so described because they are prone to recur, after removal, in the part from which they originally grew, or in the neighboring parts.

These spindle-celled sarcomatous growths on section usually present a white, glistening, semi-transparent surface, which

and under these circumstances it is readily enucleated; when the attachments are stronger or broader, they may want division with the knife, and under these conditions some vessels may require to be twisted or otherwise secured.

In exceptional cases the neoplasm is so closely connected with the breast tissue as to necessitate the removal of the lobe of the gland in which it is placed.

All bleeding should be thoroughly arrested before the wound is closed, by the torsion of every vessel of any size, and the temporary introduction into the capsule or cavity of the wound of a sponge wrung out of hot iodine water. Its edges should then be carefully adjusted by means of fine sutures and strapping, and the wound dressed, a provision being carefully made for its drainage for twenty-four hours. A little gentle pressure, applied either through iodoform gauze, salicylate wool, or a soft sponge rendered aseptic with iodoform or boracic acid, and bound on with a bandage, is most useful in checking capillary oozing and venous hemorrhage.

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Should the tumor have been allowed to attain a large size, it may be impossible to separate breast gland from growth; under such circumstances it may be necessary and expedient to excise both. It must, however, be stated that large tumors, even up to seven pounds, may be removed from a gland, and the latter left intact and capable of performing its true functions; and under these circumstances it is the surgeon's duty to attempt to save the gland, even when it may appear hopeless. These principles of practice are clearly applicable to cases met with during the child-bearing period of life. At later periods the object for retaining the breast does not exist, consequently the practice based upon it is not necessary.

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The fourth case illustrates the effects of pregnancy and lactation in the growth of an adenoma.

CASE IV.—Adenoma of eighteen years' growth, with rapid increase during lactation:

Mrs. H., aged 38, a widow, the mother of one child three years old, came under my care on June 12th, 1867, with a large nodular and fairly elastic tumor, the size of a cocoanut, in her left breast. The breast gland could be separated from the tumor without difficulty, and the nipple was natural. The tumor had been growing for eighteen years, slowly for fifteen, but rapidly after her last pregnancy and lactation. She would not consent to have it removed.

The fifth case is full of interest, since it is an example of adeno-fibroma in a woman, aged 62, and was associated with a retracted nipple, a sign which is too readily accepted as an indication of carcinoma. The new growth also was said to have followed an injury.

The sixth case likewise illustrates one of the same points, since the tumor was associated with a retracted nipple. In it, as in the former cases, the growth was placed in the centre of the breast gland.

CASE V.—Adeno-fibroma of the breast in a woman, aged 62, following a blow, associated with retracted nipple:

Dorothy S., aged 62, came under my care on July 23d, 1884, with a hard lobulated tumor occupying the centre of the left breast, associated with a retracted nipple, but no axillary glandular enlargement. The tumor had been growing for eight months, and had followed a blow received upon the part one month previously.

July 30th. The tumor was removed by making a free incision into its capsule, in a line radiating from the nipple. It was encapsuled and turned out with the greatest ease. A good recovery ensued. The tumor was an excellent example of adeno-fibroma.

CASE VI.—Adeno-fibroma of the breast, with retracted nipple, in the daughter of a woman who had carcinoma of the breast:

In 1878 I removed from the left breast of Miss N., a healthy girl, aged 18, an adeno-fibroma of six months' growth, which was placed in the centre of the breast, and gave rise to re-

left behind, or some tumor which had not been discovered. In many cases he will doubtless be right in his suspicion; but in others all evidence upon the point is deficient, and the reappearance of the growth must be regarded as a recurrent growth. These local recurrences may continue for many times. I have in one case already operated seventeen times in the course of three years, and the disease is yet quite local. (See Case I., Chapter XX., page 308.)

In some cases the disease not only returns locally, but like the carcinomata involves other organs, and particularly the viscera. Gross states "that mammary sarcoma recurs locally in 61.53 per cent of all instances, and that it gives rise to secondary deposits in distant organs in 57.14 per cent;" whilst "in carcinoma 88.35 per cent of the local recurrences are met with in the first year, while only 50 per cent of the cancers affect distant parts."

It is, however, to be remembered that Gross draws his experience from selected cases, in which the proof of the sarcomatous return of the growth was determined by histological examination.

These sarcomatous growths rarely attack the breasts of young women, but rather of those over 30 or 35, and they are not uncommon in women about fifty years of age. They are found also in male subjects; out of 68 examples of sarcomata of the breast consecutively observed in four large London hospitals, according to Dr. W. Williams, two were in men.

Diagnosis.—The diagnosis of an adeno-sarcoma from an adenoma or adeno-fibroma is difficult, and in many cases clinically impossible. Its true nature is to be determined better by its progress and clinical history than by its physical features. A lobulated, slow-growing, firm, fleshy, movable growth in the breast of a young woman is probably a "fibroma," and not a sarcoma; whilst an ovoid, smooth, elastic tumor, of somewhat rapid growth, in the breast of a woman over thirty, is probably a sarcoma. The younger the patient, the more lobulated the neoplasm, and the slower its growth, the greater the probability of the tumor being a fibroma. The older the patient, the smoother the outline of the tumor, the more elastic its feel, and the more rapid its growth, the greater the probability of the neoplasm being a sarcoma. When the integument covering in the tumor, which was solid,

is ulcerated, and the growth appears through the orifice as a sprouting, fungating mass, the disease is probably sarcomatous, although, should the disease have been cystic, this conclusion would not be so clear. As to the relative frequency of adeno-sarcomatous and adeno-fibromatous tumors, out of my last hundred cases of these collective growths but four were pronounced to be sarcomatous.

"A tumor," writes Gross (p. 99), "of soft, elastic, apparently fluctuating consistence, which attains the volume of an adult head in a few months, can scarcely be anything else than a small-celled sarcoma. On the whole, the diagnosis is based upon their indolent origin, lobulated outline, rapid increase, large dimensions for the period of their existence, freedom from lymphatic involvements, and marked tendency to ulcerate; upon the not infrequent discoloration of skin, enlargement of the subcutaneous veins, and possibly, elevation of temperature; upon the suffering which they awaken late in the disease, and upon their greatest frequency after the thirty-fifth year."

Treatment.—These neoplasms cannot be taken away too early; they should be excised as soon as they are discovered. They should not only be excised, but the parts around them should likewise be taken away, that is, the lobe in which the growth originated. The whole gland should only be removed when it seems to be involved in the disease; it is better, however, to err in these cases by taking away too much than too little.

Recurrent growths should likewise be dealt with in the same thorough way. These are at times multiple, and when so, the operation must be extensive. I have removed recurrent growths from one patient seventeen times in three years, and at the last operation, in 1887, the disease was still local. Indeed, there is good reason to believe that by removing the local affection, even after many recurrences, the disease is prevented from becoming a general one, and involving internal organs. In a case of small spindle-celled sarcoma, Gross succeeded, after removing fifty-two tumors by twenty-three distinct operations (the last few of which included portions of the pectoral and intercostal muscles, in a period of four years and a half) in checking the reproductions, and the patient was perfectly well nearly eleven years subsequently. Gay, Birkett, Heath, S. D. Gross, and Haward have likewise

reported cases, showing the advantages of repeated operations in cases of recurrent sarcoma.

In many of these cases, after removal of the tumor, it is wise to leave the wound open, and let it granulate, after having well swabbed its surface with a twenty per cent solution of chloride of zinc. I have thought that this plan of treatment destroyed such cell elements as might have remained after the operation, and in this way retarded, if not prevented, recurrence. When lymphatic glands are enlarged they should be taken away, but the prospects of anything like a cure under these cicumstances are very feeble. Indeed, when the lymphatic glands are involved in sarcomatous growths, the prognosis is as bad as possible, and the surgeon should consider carefully as to the expediency of advising any operation. It may safely be said that it can be in only exceptional cases a justifiable measure.

By way of further illustration of the subject, the following cases may be quoted:

CASE I.—Adeno-sarcoma of breast; excision of tumor; recurrence of growth; ability to suckle with breast between while; excision with the breast; well two years later, five years after the appearance of growth.

Elizabeth M., aged 36, was admitted into Guy's Hospital under my care on the 14th of July, 1880, and was discharged on the 16th of August, 1880.

The patient is a married woman, and has eight children, seven of whom are living. She was in Lydia ward three years ago under my care, when I removed a tumor from her breast.

Her father and mother are both alive; there is no history of cancer with them; one of the patient's brothers died of tumor of the liver.

The old report of her case describes her as a healthy-looking, well-nourished woman; she entered the hospital 7th June, 1877, and then had a large tumor occupying the left breast, but extending chiefly downward, and outward toward the left axilla. There was a scar to the outer side of the nipple, which was caused by a surgeon making an incision some weeks previous. The circumference of the left breast was 18 inches. On June 19th, 1877, patient was put under chloroform, and Mr. Bryant made a transverse incision eight inches

long, reaching from the outer boundary of the tumor, inward and toward the level of the nipple, so that the growth was removed without extirpation of the breast. A large axillary gland was also removed; the great size of the arteries was very noticeable, one of these being as large as the radial. The growth weighed 2 lb. 4 oz., and was composed of a number of cysts, some containing a milky fluid, and others more solid contents. The patient left the hospital on 18th July, with the wound almost healed, and in a fairly satisfactory condition.

Since leaving the hospital, the patient has had one more child, and she has been able to use the left breast in nursing; the child was weaned about twelve months since; about this time she first noticed a small lump just above the nipple, which has been increasing ever since.

On admission there is a large lobulated tumor, divided into two chief parts, involving the left breast. One of these parts occupies the central or upper half; the other, which is the smaller of the two, is placed on the axillary side of the gland. The tumor is above the level of the old cicatrix. It is freely movable, with a lobulated surface, elastic to the touch; hard in some places and moderately soft in others, and it is cystic in character; the skin over the tumor is not involved. One boss, which is most prominent, and placed just above and to the inner side of the nipple, is inflamed and painful. On July 20th, 1880, the tumor, with the breast, was removed, and a good recovery followed.

The tumor was everywhere encapsuled, and was composed of many lobules, separated from one another by fibrous septa. Some of these lobules grew into the walled cysts, which contained little or no fluid, their walls being in contact. The growths in these cysts were in some cases lobulated finely on the surface, whilst in a few they resembled in color and smoothness a mucous nasal polypus, although in consistence they were a little firmer. The majority of the lobules showed on section a finely lobulated appearance, the outlines of the little lobules being crescented, some having a distinct cavity in the centre. No communication could be traced between the various cysts, nor could any be traced directly to the nipple. Some parts of the growth were firm, hard, and fibrous; there were no blood cysts or any translucent-looking material, in the growth.

In some of the nodules (felt to be elastic during life) there were many elongated slit-like spaces with smooth walls, the bounding material being acinous.

In September, 1882, this woman was still well.

CASE II.—Spindle-celled adeno-sarcoma of breast; tumor weighing two pounds on removal; recovery; patient well six years later.

Matilda H., aged 49, the mother of three children, the youngest being 18, came under my care on October 7th, 1874, with a large tumor apparently involving the right breast. The tumor had been growing for two years, and when first discovered was about the size of a nut; it has grown steadily, but for the last two months rapidly. It has never been the seat of much pain; an occasional dart of pain through it is all she has felt.

When seen, a smooth globular swelling occupied the position of the right breast. The skin over it was stretched, and the circulation through it was impeded, as shown by the enlarged veins. The nipple was flattened, and the axillary lymphatic glands were natural. On October 13th the tumor and breast were excised, and a good recovery followed. The tumor was found to have been placed behind the breast, or rather in the posterior part of the breast. It was closely connected with the gland, but not infiltrating it. On section it was made up of fibro cellular elements, containing within its meshes spindle cells. It weighed two pounds.

Six years later this patient was quite well.

CASE III. -Adeno-sarcoma (spindle-celled) of breast; excision; cure; patient well two and a half years later.

Fanny C., a married charwoman, aged 50, the mother of five children, all of whom she suckled, came under my care January 25th, 1878, with a tumor in the upper part of her right breast, which she had accidentally discovered six weeks previously. It was then the size of a pigeon's egg, smooth and painless. When coming under care the tumor had much increased; it was about two and a half inches in diameter, firm and fleshy to the feel, and fixed in the axillary lobe of the right mamma. The skin over the tumor was healthy. Nipple natural, axillary glands not to be felt. An adeno-sarcomatous tumor was diagnosed, and removed, with the breast, on January 29th, and the woman did well. The temperature never

rose above 99° after the operation. Two and a half years subsequently she was known to be well.

The tumor, on examination, was found to be encapsuled, but closely connected with the breast. It was a semitransparent, succulent, very vascular neoplasm, and under the microscope was clearly a spindle-celled sarcoma.

CASE IV.—Adeno-sarcoma of breast; excision of the gland and tumor; two years later the opposite breast became involved; this was excised; and two years later still the patient was well.

Mary S., aged 33, a single woman of healthy aspect, came under my care in April, 1877, with a swelling in her left breast, which she had detected as a small lump eight months previously. When seen, a tumor was readily made out to exist in the upper and outer border of her left breast, which was so closely connected with the gland, that both moved together. The nipple with the skin over the tumor was natural, and the lymphatic glands were not enlarged. On May 15th an incision was made into the tumor, and as it was found to be intimately connected with the breast gland, both were removed. The patient did well. The growth was found to be a spindle-celled sarcoma.

In August, 1879, that is, two years after the operation, the patient re-appeared with a growth in the right breast, which had been increasing for one year, and followed the same course as the one in the left. It was placed in the upper part of the gland, and seemed to be part of it: it measured about two inches across. On August 12th the breast and growth were removed, the patient doing well. The tumor was precisely of the same character as the former one. Two years later the patient was well.

CASE V.—Round-celled adeno-sarcoma of both breasts; removal of both; patient well two years later.

Mrs. G., aged 24, the mother of one child, consulted me in December, 1868, for a swelling the size of an egg in her right breast, which she had discovered during her only pregnancy, four months previously. She had been suckling, when I saw her, three months. The swelling was fleshy, smooth, and painless, and was clearly growing fast. Weaning the child was advised. By July, 1869, the tumor had increased to nine inches by seven in diameter; the skin over it was healthy;

nipple natural; axillary glands uninvolved. It was then removed, with the breast, by the late Mr. Ashforth, of Rutland, and sent to me for examination. It was a soft, succulent, pinkish, homogeneous growth which, on section, exuded a glutinous fluid. It was made up of round cells, and some adenoid tissues. The patient did well.

Four months later a like growth appeared on the left, or opposite breast, with some enlargement of the axillary glands of the same side. These I removed, with the breast at once.

One year later I saw this lady with an excellent cicatrix, and after the lapse of another year she was reported as well.

CASE VI.—Large cystic sarcoma of the left breast; amputation; recurrence; exhaustion; result, death.

Emma S., aged 52, a cook, was admitted into No. 3, Lydia ward, under the care of Mr. Bryant, on December 4th, 1883, and discharged on the 15th February, 1884; she was readmitted on the 2d April, 1884, and died on the 6th May, 1884.

The patient is a single woman; her father and mother died of old age; she has one brother and five sisters, all healthy. Fifteen years ago patient had small-pox, but since has been quite healthy until ten months ago, when she had bronchitis. About this time she noticed a small hard lump, the size of a kernel, in her left breast, just above the nipple; the growth slowly increased; it was not painful; seven months later it had attained about the size of a fist; no aggravation of symptoms took place during the periods of menstruation.

On admission, the patient is a fat, healthy-looking woman; there is a large-sized tumor occupying the position of the left breast, which measures 30 inches round its base, 16½ inches across the nipple from above downward, and 17½ inches from right to left in the same direction (Plate I., Fig. 4). From the measurements it will be noticed that the growth has doubled in size in the last two months. The surface generally of the tumor was congested, with enlarged and engorged subcutaneous veins over the upper two-thirds of its surface; the skin was tense and shiny, and over several areæ the tumor was more prominent and the skin blue, with a mass of dense network of enlarged veins; there were two large bosses above the nipple, which were raised, measuring 3 inches by 3. Areola and nipple were somewhat stretched out: there was no evidence of fluctuation; the surface above the nipple was

tender and painful to the touch, and gave evidence of indistinct fluctuation in several spots; there was no involvement of the axillary glands; the patient complains of a darting pain at times through the tumor; the temperature, just after her admission, was 99°.

On December 7th Mr. Bryant removed the tumor with the breast, and the case ultimately did well; the patient leaving the hospital convalescent.

The patient was re-admitted on April 2d, 1886.

History of the Secondary Growth.—The patient noticed round and over the old wound, before it had entirely healed, some return of the growth; on readmission the swelling had extended all over the left breast, and at an elevated spot, near the axilla, it had broken down. The discharge from the growth was very small at first, but it has since gradually increased, and pain has accompanied it more or less all the while. She has some nerve-pain down the arm to the elbow.

Condition on Re-admission.—The patient looks very healthy, but this has been her general appearance all along. The seat of the former tumor is involved with new growth, but there is no lymphatic glandular enlargement. The tumor extends externally to the anterior fold of the axilla; internally as far as the middle of the sternum; above as high as the upper margin of the first intercostal space; and below it runs downward to the eighth rib. It presents two sloughing surfaces, one about two inches square, over the sternum, at the upper and inner angle; the growth being composed of four nodules which have united and formed one mass, the surface of which is sloughing.

About two inches external to this is another single nodule, which has a sloughing surface; the edges of the two are clean cut and well defined, and over the whole circumference there are various nodules, which are soft and rather painful. The skin appears brawny and of a red color. The whole mass moves freely over the ribs and deep parts. The patient's powers steadily failed under the exhausting effects of the discharge from the broken-down growth; and she died on May 6th. No secondary growths were found.

Melanotic sarcoma of the mammary gland is a very rare affection, and as a primary disease I believe it to be unknown. In the two following cases it was of a secondary character.

CASE VII.—Melanotic sarcoma of the breast, skin, and axillary glands, following the removal of a growth originating in a mole.

Lydia M., aged 36, a married woman, the mother of one child, nine years old, came under my care in December, 1857, with her right breast covered and filled with "lumps" the size of nuts; the skin tumors were evidently of a melanotic nature, and extended to the integument covering the sternum and abdomen, some few being in the back. The axillary glands were much enlarged. On going into the history, this woman had had a black tumor the size of a walnut removed ten months previously from her left fore-arm, which had originated in a mole, and had been growing one year. The cicatrix of the operation wound was sound.

CASE VIII.—Melanotic sarcoma of breast following the excision of a melanotic tumor originating in a mole over the sternum.

On October 18th, 1867, I was consulted by a Mrs. M., a married childless woman, aged 55, from whose sternum a tumor had been removed four months previously, which had been growing four months in a black mole. It was removed by Dr. Richards, of Redruth, when about the size of a duck's egg, and was supposed to have been a cancer. When I saw the patient there was clearly a melanotic growth in one breast, and many disseminated tubercles of melanotic sarcoma scattered over the sternum, breasts, abdomen, and enlarged lymphatic axillary glands, for which no operation was justifiable.

In Chapter XX., which deals with associated growths of different kinds, two cases, VIII. and IX. will be found in which carcinoma of the breast and melanotic sarcoma were found in the same patient.

CHAPTER XII.

CARCINOMA OF BREAST

(AN EPITHELIAL INFILTRATING GROWTH).

CARCINOMA always originates in epithelial tissues, and is composed of epithelial elements.

These elements invariably infiltrate the tissue in which they are placed, and spread from their primary seat to neighboring structures by a progressive infiltration, so that as the disease advances, skin and fat, muscles, bone, nerves, and vessels eventually become involved, although the structures named vary in their powers of resisting the infiltrating tendency.

In carcinoma of the breast, the gland structure is the one primarily involved; and the epithelial elements of which it is composed partake of the anatomical characters of the normal epithelial lining of the ducts, or acini. The cells in the early stages of disease, where they are in contact with the basement membrane of the gland, are arranged with a certain kind of regularity; but at a later period they are most irregular, in the lumen of the duct, in the centre of the acinus, and in the connective tissue of the parts outside the basement membrane; the vessels of the growth are distributed to the fibrous stroma of the tissue infiltrated, and not, as in connective tissue or sarcomatous tumors, between the cells.

The epithelial cell elements in their infiltrating progress affect the invaded tissues in a particular way, and the cells in an early, if not in the earliest period of disease are found to be placed between the normal fibres, ducts, or gland elements of the invaded structure in what are called alveolar spaces. These spaces vary in shape, size, and in the arrangements of their epithelial contents, and each alveolar arrangement apparently depends, in the early period of disease, upon the anatomy of the tissue primarily infiltrated.

The alveolar spaces, whether large or small, freely communicate with one another in different places, and when a section of a tumor is made, and its surface scraped, the contents of the spaces readily escape as "milky" or "cream-like" cancer juice; this juice being composed of the epithelial cells, massed together, or floating in an albuminous fluid; the cells composing the juice being large or small, with one, two, or more round or oval nuclei.

This alveolar arrangement does not, however, hold good forever; it does so only so long as any normal tissue remains uninvaded or unchanged. For it is to be recognized that in all cases of carcinoma, as the infiltration of the epithelial elements progresses, so the disappearance of the tissue infiltrated is to be traced, until at last the natural structure of the invaded parts, even of bone, becomes entirely replaced by the carcinomatous elements. Over and above this, there is more or less in all infiltrating tumors a proportion of granulation or indifferent cells, from which of themselves the nature of the tumor could by no means be distinguished.

Neoplasms, like normal tissues, are liable also to certain pathological processes, and tumors of the breast are obedient to this law; thus they may inflame and suppurate, or ulcerate, and they may likewise undergo chronic degenerative changes. The life history of these epithelial or carcinomatous infiltrating tumors is not usually a long one, and every such tumor having arrived at maturity, begins to degenerate and to die, the process of death being in some cases slow, in others rapid. When slow, the process is by what is known as caseation; when rapid, by sloughing; this latter process, in some cases, being apparently helped by what much simulates an inflammation. At times a tumor may caseate in its centre and break down, so as to form a cavity containing a bloody or serous fluid simulating a cyst. In rarer cases the growth will undergo what is called the "colloid transformation," a form of degeneration peculiar to carcinoma, and not known to occur to the sarcomatous group. Of external tumors, those of the breast are mostly liable to this form of degeneration, whilst the more common examples of colloid transformation have been usually met with in the abdomen. In this change the growth becomes a gelatinous mass of a yellow or pinkish-red color, and on section this material flows like transparent honey

or mucus; it differs, however, from mucus in not being rendered opaque by acetic acid, and in containing sulphur; the alveoli of the changed growth enormously increase in size, and the epithelial cells of which it was composed swell into glistening globes, unaltered epithelial cells being often found in the centre of the mass.

In what way the epithelial cells of carcinoma that infiltrate the invaded tissue are formed and propagated may be open to dispute. In some cases it would appear that from either a known or unknown source of irritation, the natural elements of the epithelial tissue increase and multiply, and following the line of least resistance, dip into the tissues upon which they are placed, and so infiltrate them.

In others, where glandular structures are involved, as in the breast, the epithelial elements may first collect within the acinus, or tubule of the gland, and then make their way into the tissues outside, from rupture of the basement membrane of the acinus wall.

In a third class of cases, or perhaps in all to a degree, the disease spreads by what is called "*infection*," that is, the aquired power possessed by the developed morbid epithelial cells, when coming into contact with embryo undeveloped cells, of influencing their development, and causing them to take on the epithelial form. In the same way as in the cicatrization of a granulating wound, the epithelial cells of the true skin at the margins of the sore influence the embryonic granulation tissue elements in contact with them to form new skin.

How far this "infecting" power influences the young connective-tissue cells to assume the epithelial form in the growth of tumors, which originate in a glandular organ, and secondarily invade connective-tissue structures, it is not possible to say; although it is probable that such an influence is an important one, since it is certain that epithelial growths increase rapidly as soon as their epithelial elements have escaped from the acini of the gland, in which they originally increased and multiplied, by what is known as ordinary generation, and become disseminated into the fibrous or connective-tissue structure around the gland.

So long as a new formation in a glandular organ is confined within the limits of the organ; so long as it retains both in structure and function the type of the normal tissue, it con-

stitutes an adenoma. But when the new growth "becomes destructive toward the surrounding tissues," when it proceeds to infect the neighborhood, it becomes cancerous. The additional element in the case of cancer is clearly secondary to, and not co-ordinate with, the initial disturbance. Epithelial cells, and in fact the same kind of epithelial cells, are produced in two ways, but the two modes of formation do not belong to the same category; the one is a modification of healthy action, and the other is simply a mimicry of the original departure from the normal.

Carcinomatous tumors, moreover, at some time of their history cease to be local diseases; and it seems probable that this great change in the clinical character of the disease is marked by the pathological change, to which attention has just been drawn, namely, the escape of the epithelial elements through the basement membrane of the tube or acinus in which they primarily grew, and the secondary infection of the surrounding connective tissue by the epithelial elements.

"The cancerous element in the disorder," writes Creighton, "first shows itself when the infiltrated epithelium produces what we agree to call infection of the connective-tissue cells with which they are in contact."

How Cancer Spreads.—When a cancer or carcinomatous growth ceases to be a local disease, it spreads in three marked ways: by "continuous or local infection," by "lymphatic infection," or by "secondary vascular infection;" and whilst in any given case one form of infection may be more marked than another, in others all forms may exist together. In the breast any one or all may co-exist.

By "continuous local infection" is meant the gradual involvement of surrounding structures, in the order of their arrangement, around the primary seat of the disease, by progressive infiltration, as well as by extension along the perivascular sheaths of the blood-vessels of the diseased part; this being a common feature of scirrhus.

By "lymphatic infection" is meant the infiltration of the lymphatic glands associated with the primary diseased centre, or its coverings, by the lymphatic ducts, the elements of the disease being carried either by the lymph to the glands, or the lymphatic ducts themselves becoming directly infiltrated.

By "secondary or vascular infection" is meant the prop-

agation of the disease by other than the two methods already described, and probably by the blood currents; the evidence of this infection being afforded by the existence of one or more secondary growths, similar to the primary growth, in the viscera or other parts of the body, as, for example, in the pleura or liver in cases of scirrhus.

Local recurrence after removal of the primary growth in apparently the most complete manner is another sign of malignancy which is common to the carcinomata, as well as to some forms of sarcomata. It is a common feature of breast cancer.

With these general remarks on carcinoma, I will pass on to consider the disease as it affects the breast, and is seen at the bedside.

Signs and Symptoms of Carcinoma.—When a surgeon finds in the functionally inactive breast of a woman over forty years of age, or in one even ten years younger, a thickening or induration and apparent infiltration of one of its lobes, and with this local infiltration he fails to discover any other symptom or sign of a local inflammation, he is at once led to suspect the existence of a carcinoma; and when in the course of a few weeks or months the infiltrated lobe has increased in size, or the infiltration has spread from the lobe of the gland in which it originated, either to other lobes, or to some of the tissues that cover or lie beneath the breast, the diagnosis of a scirrhous carcinoma, or a cancerous tumor of the breast is plainly confirmed; the spreading of the local affection being indicated by either a "dimpling," or "puckering" (Plate III.), or infiltration of the skin covering in the lobe, or by diminished freedom of movement of the breast over the pectoral muscle.

When, again, a pathologist makes a section of a tumor involving the breast, and the section cuts crisply and becomes concave, shows a glistening surface of a grayish-white color, and dotted over with yellow spots and streaks; when he finds the disease to have originated in the gland structure, and to have infiltrated its tissues as well as to be deficient in everything like a capsule; when he scrapes the cut surface, and the scraping yields a milky juice (cancer juice), which under the microscope presents epithelial cell elements, with large round or oval nuclei of great variety; and when, on a closer histological examination, sections of the growth are made, and the

pathologist discovers that these epithelial elements have been scraped from larger or smaller slit-like oval or rounded alveolar spaces lying between the tissues of the affected lobe or gland, and that these epithelial elements otherwise possess no definite order of arrangement, he at once pronounces the disease he is examining to be carcinomatous or cancerous.

It must be understood, however, that there are no such special cells as "cancer cells." Those found in cancer are truly epithelial, but they are enlarged and deformed, many of which possess multiple nuclei, and are very prone to undergo fatty degeneration. Their arrangement also differs widely from the normal: they have no such regularity in their arrangement upon their basement membrane as seen in the adenomata, but their membrana propria is destroyed, and the lymph spaces of the connective tissue are infiltrated by the solid cell cylinders.

Should the pathologist, on further dissection, discover that the tissues outside the area of the gland are involved in the disease; that no boundary line of any kind can be made out to exist between the healthy and diseased parts; that the capsule of the gland where it originally encased the healthy lobe has disappeared, and been replaced by a new cell growth; and that this same form of neoplasm which originated in the centre of the diseased gland has radiated outwardly through the capsule of the gland into the fatty structure that surrounded it, and probably through this fatty structure either to the skin or the muscles beneath, so as in the former case to bring about, first, a drawing downward of this structure (dimpling, Plate II., Fig. 1), secondly, early infiltration (puckering, Plate II., Fig. 2), and thirdly, marked infiltration (induration), or in the latter case fixedness of the growth and its immobility from the pectoral muscle: when these facts are discovered the diagnosis of cancer is absolute. Indeed, both the clinical as well as pathological facts demonstrate that the disease, which began by infiltrating a lobe of the gland, has spread rapidly by the same infiltrating process; that it has passed from the lobe primarily involved through its capsule, and from this through adipose and connective tissue, either to the skin itself or pectoral muscle beneath, so that at last the skin had become infiltrated, and so changed. For carcinomatous infiltration of any tissue means eventually epithelial

substitution; and tissues that are at first invaded or infiltrated, in the course of time entirely disappear, their elementary tissues steadily giving way under the infective influence of epithelial infiltration; so that at length the natural structure of the mammary gland becomes superseded by the epithelial elements.

From these considerations it may be asserted that four main pathological points so far stand prominently forward in carcinoma of the breast. The first being that the disease is an infiltrating one; the second, that the infiltrating elements are epithelial, and nothing else; the third, that whilst the disease may have originated in one structure, say one lobe of the breast, it will eventually locally infect neighboring structures by a progressive infiltration (extension by local infection); and fourthly, that the normal structures invaded or infiltrated will eventually be destroyed and superseded by the epithelial infiltrating material.

Cancerous tumors, however, whilst they locally spread by local infection, do so in other ways, and of these, the method by lymphatic infection is the most frequent, the epithelial elements being either carried directly by the lymph stream from the lymphatic spaces of the infiltrated tissue, through the lymphatic ducts, to the neighboring axillary, clavicular, or substernal glands, or the walls of the lymphatic ducts themselves become absolutely infiltrated with the cancerous elements, and thus the local disease is conveyed by direct extension to the lymphatic glands themselves. It is probable that both these two methods have their influence, and that the first is the more common.

Again, carcinomatous disease spreads by "vascular infection," that is, by the blood-vessels, and so becomes disseminated broadly into the viscera and other distant parts of the body; local infection, lymphatic infection, and vascular infection being the chief methods by which cancerous disease spreads.

The Varieties and Macroscopical Features of Carcinomatous Growths.—There are clinically six classes of cases of carcinoma of the breast, although "the varieties of carcinoma are determined by the relative proportion of the stroma and cells, by certain degenerations and transformations, and by the accidental formation of cysts" (Gross).

1. The very slowly growing, and subsequently atrophying,

scirrhous carcinoma (Plate II., Fig. 3; Plate III., Fig. 3; Plate III., Fig. 5).

2. The more common variety, or hard, fibrous, infiltrating form of carcinoma (Plate III., Fig. 2).

3. The soft, more cellular, and encephaloid variety (Plate III., Fig. 4).

4. The acute brawny cancer (Plate II., Fig. 7).

5. The colloid cancer (Plate II., Figs. 7 and 8).

6. The cystic carcinoma (Plate IV., Fig. 4).

The first variety (Plate II., Fig. 3), or the very slowly growing, and subsequently atrophying, form of scirrhus, is the hardest kind met with, and is often described as stone cancer; it rarely attains any large dimensions, and is characterized by its peculiar power of contracting all the tissues involved in its infiltrating influence into little more than a puckered scar, with a central hard stony nucleus. When the centre of the breast is its starting point, the breast gland, with its nipple and skin covering, may all be drawn together into a cicatrix-like fissure. And when the primary growth occupies the periphery of the breast gland, the same contractive powers will be visible, although without any retraction of the nipple. In Plate III., Figs. 5 and 6, this condition is well illustrated.

The disease may progress so slowly as to last twelve, or even twenty years, and at the end appear only as a local disease; whilst in other cases a tumor, that for years had grown but slowly, may suddenly take on active growth, and develop into an acute or subacute form of cancer.

During the progress of this withering scirrhus, tubercles may appear in the skin of the primary growth and in this neighborhood, which may appear and even disappear, the disease progressing and receding at the same time. Should the growth be irritated or interfered with, it may become active, and what has been a local disease will become a general one by lymphatic and vascular infection. Patients the subject of this form of cancer, as a rule, die from visceral metastatic growths rather than from the local disease. A section of a tumor, such as the slowest growing of this series, will cut crisply, present a concave surface of gray appearance, with the remains of old gland ducts. There will exude from its surface but little juice, and this juice will contain but few epithelial cells; and what are seen will probably be undergoing fatty

or granular degenerative changes. The fibrous stroma will be abundant, and the alveoli which contain the epithelial elements will probably only show as slits or fusiform clefts. This form of carcinoma may clinically for a long period be regarded as a local disease, although at a later period it spreads by lymphatic infection.

In the following brief notes of cases, many of these points will be well illustrated.

CASE I.—Carcinoma fibrosum of right breast; disappearance of local disease by natural processes; death of patient of chest disease seventeen years after first appearance of disease.

H. B., a healthy-looking, childless, married woman, aged 53, came under my care in January, 1857, with an ulcerating carcinomatous tumor of her right breast. The disease had existed for six years, and ulceration had been present for four. The cancerous surface was about the size of the palm of the hand. It was of stony hardness and firmly fixed to the muscles. Its edges were nodular and crumbly; the axillary glands were also enlarged. Her general health was good, and as the tumor caused little pain, operative interference was rejected. In March, 1858, fifteen months later, the tumor had become much smaller, and several pieces the size of nuts had fallen off, having apparently been destroyed by the contraction of the fibrous elements of the neoplasm. The growth as a whole was much harder. General health still good. October 20th, 1858, six months later, much of the original tumor had crumbled away, and the tumor was much smaller. Some tubercles had, however, appeared in the skin over the sternum.

April 21st, 1859. Tumor continues to contract, and to throw off pieces. The tubercles in the skin are likewise contracting and becoming paler.

November, 1859. Axillary glands becoming smaller and more indurated.

July 23d, 1861. The breast has nearly cicatrized, a mere linear puckered scar remaining, in which are one or two small hard white tubercles. All the secondary tubercles of the integument have disappeared.

January 3d, 1862. Nearly cured.

June 1st, 1862. Only one small tubercle the size of half a nut

remains in the cicatrix. No fresh tubercles have appeared. The glands in the axilla can hardly be felt.

March 31st, 1863. Breast shows merely a cicatrix, in which there is only one small nodule the size of a pea. The woman in all other respects is well.

May 30th, 1864. The breast is still in the same condition; one or two tubercles have appeared in the integument near the cicatrix, and have again disappeared. Two tubercles are, however, still present.

June 30th, 1864. The patient considers herself to be well. Her skin tubercles cause no pain or inconvenience. This is the last note of her case I have, but I learnt later that this patient died in 1870 of some chest trouble. The local disease had not increased.

CASE II.—Atrophic cancer, twelve years' growth; patient survived fifteen years.

Miss B., aged 50, who had had atrophic cancer of her left breast for twelve years, with enlarged axillary glands, came under my care on September 13th, 1868, when the nipple and skin around, and breast gland were all involved in a hard, puckered, cancerous tumor. This patient lived for three years and died from some acute chest trouble.

CASE III.—Atrophic cancer of twenty years' standing.

Jane H., aged 72, the mother of two children, and a widow of fifteen years, came under my care in 1869 with a puckered carcinomatous infiltration of her left breast of twenty years' existence. The whole gland, and the skin over it, and the axillary glands were involved, although the nipple was natural. Secondary tubercles were very general in the skin. This patient died one year later of asthenia.

CASE IV.—Atrophic cancer of breast, nine years.

Bridget M., aged 56, the mother of three children, came to me on August 18th, 1868, with an atrophic cancer of her left breast, which had existed for nine years, with skin tubercles for the last two years over the breast and surrounding skin. She was steadily losing strength, and died within a year.

CASE V.—Atrophic cancer of breast, eight years.

Ann H., aged 69, the mother of one child twenty-eight years old, came to me on May 31st, 1866, with infiltrating carcinoma of the left breast of seven years' growth. The nipple was retracted and the axillary glands were enlarged. The skin over

the breast was only puckered, not infiltrated. This patient, I believe, lived three or four years after my seeing her. The cause of her death is uncertain.

Second variety (Plate II., Figs. 1 and 2; Plate III., Fig. 2).—The second or more common variety of the hard, fibrous, infiltrating form of cancer differs only from the last, or atrophying kind, in that it is more rapid in its progress, and does not tend to wither. In it the bundles of fibrous tissue are abundant and the cell elements comparatively limited; at the same time they are far more abundant than they are in the atrophying kind. The alveolar spaces which contain the irregularly heaped-up cells are ovoid or round, and the disease runs its course far more rapidly; three years being about the average duration of life of a person who is the subject of it. This variety of cancer is the common form, as met with in practice.

The tumor rarely attains a size larger than that of an egg, but it never retains the smoothness and regularity of its shape. It has always an irregular bossed outline, and may affect the skin in ways to be described (Chapter XIII.). A description of a section of this tumor has been given (page 147), the tumor, taken as a type of carcinoma of the breast, having been drawn from this group, since it is the most common.

Third variety (Plate II., Fig. 4; Plate III., Fig. 4).—The soft tuberous, or encephaloid variety of carcinoma is likewise an infiltrating one, but it differs from the two preceding varieties in being larger in size, more rapid in its growth, and softer in its consistence. It may readily be broken down by the finger. On section it has a homogeneous, brain-like, white or mottled pink or red surface, with probably some more or less extensive local extravasation of blood within its structure. In parts, the tumor may be breaking down from degenerative processes. The cut surfaces are less concave than are the scirrhous forms, and much juice exudes from them. The juice contains abundant cell elements; a fine section of the tumor shows little fibre tissue, but large, round, alveolar spaces filled with round large cells.

Fourth variety (Plate II., Fig. 7).—The acute brawny cancer, although it simulates the last two varieties, is a variety by itself, in that it is an acute disease, and appears as a rapid

infiltration of a breast with the skin over it. The nipple, as a rule, is retracted and much depressed; the soft parts around it are raised, and the nipple depression is thus made apparently greater. Occasionally, as in Plate II., Fig. 7, the nipple is infiltrated and raised; the skin over the breast is brawny with infiltration, and at times it may be œdematous, so as to pit on pressure; it may likewise be injected as if inflamed, and hot to the hand.

In other cases the skin over the infiltrated breast gland will be indurated and tuberculated, the skin and the tumor having become by local infection one infiltrated carcinomatous mass.

A section of such a tumor will be firm, but not so hard as in class 2, or so soft as in class 3; it will present on section a white glistening appearance, with abundance of cancer juice containing cell elements (Plate III., Fig. 4). The fibre tissue will not be very abundant.

To the pathologist's eye the disease will probably be able to be traced from the gland or lobe in which it originated into the neighboring structures, and even into the skin, the section of which will be thick and white, from the infiltration of the epithelial cell elements.

This form of cancer of the breast is the most acute met with, and the most rapidly fatal; it may run its course in a few months. It is a type of an acute infiltrating neoplasm.

Fifth variety.—*Colloid carcinoma* (Plate III., Figs. 7 and 8).—This is a degeneration of a carcinomatous growth to which attention has been drawn (page 144, and also at page 196).

Sixth variety (Plate IV., Fig. 4.)—The cystic carcinoma will be considered under the heading of cystic disease of the breast. The existence of cysts in the carcinomata clinically separating cases which contain them from the more solid varieties of the disease, in the same way as the presence of cysts renders a different consideration necessary of the cystic and solid forms of adeno-fibromata and sarcomata.

Of the first four classes just described, there are endless intermediate varieties; and there is a chain of connection which links at one end, class 1, as represented by a small tumor of stony hardness, which has slowly drawn to itself, by local infection and infiltration, breast tissue, with its coverings, so as to appear as an indurated, puckered, and painless nodule, with

classes 3 and 4 at the other end, which exists as a soft, rapidly growing, succulent tumor, the size of a fist or cocoanut, having a rounded nodular outline and elastic feel, with full veins coursing over the skin which covers it, or with the skin mottled, infiltrated, and consequently adherent to the parts beneath.

In the former case the growth will have been of slow growth, even of many, say twenty, years; in the latter case it will have been of rapid growth, probably of weeks.

Neither of these extreme types is, however, of frequent occurrence, as one represents the withering or atrophying form of scirrhus, and the other the exceptional encephaloid or tuberous kind.

Influence of Sex.—Carcinoma of the breast is met with in both sexes. Mr. W. R. Williams, in his work on "The Influence of Sex in Disease" (1885), tells us that from an analysis of all cases admitted into the Middlesex, St. Bartholomew's, St. Thomas's, and University College Hospitals, during ten, twelve, and seventeen years, ending 1883, "out of 11,100 cases of tumor, 53 per cent were cancerous; out of 5,978 cases of cancer, 24 per cent were of the breast, and out of 1,433 cases of cancer of the breast consecutively observed in the above hospitals, 14 were in males.

Two out of every five cases of cancer in women are of the breast; one out of every three is of the uterus.

There is but one case of cancer of the male breast to 101 of the female breast.

Out of one hundred consecutive cases of carcinoma of the breast which I have observed, six have been of the atrophying form (class 1), ninety of the ordinary scirrhous variety (class 2), and four of the brawny kind (class 4).

What has been usually described as medullary or encephaloid cancer I now believe to have been probably of a sarcomatous nature; although some of the cases may have been of the tuberous variety, class 3. The fact of a tumor being encephaloid and limited by a membrane clearly excludes it from the carcinomatous series, carcinoma under all circumstances being an infiltrating neoplasm. Paget believes that there are about five cases of encephaloid carcinoma in ninety-five of scirrhus; whilst Lebert states that in France one case of encephaloid is met with in every five cases of carcinoma.

Influence of Age.—Carcinoma is not a disease of young life, although Mr. Lyford has recorded[24] a case in which it was found in the breast of a girl, aged 8; Mr. B. B. Cooper has reported a second[25] in a girl, aged 16, and in the Museum of St. Bartholomew's Hospital there is a specimen which was taken from a girl, aged 16.[26] Dr. Henry, of Breslau, recorded a fourth case in a woman, aged 21; and Mr. Tilley a fifth in a woman, aged 26. I have seen one example in a woman, aged 25, and two examples in women, aged 28, one of which was of the scirrhous variety, and the second of the acute brawny kind. Within the last few weeks I have seen a case in a young married woman, aged 26, in whom the disease appeared during pregnancy. It had all the features of the brawny variety. Nothing could be done for it.

An analysis of 600 consecutive cases of my own tells me that:

In 25 cases, or 4%, the disease was discovered before 30 years of age.

In 163 " or 27%, the disease was discovered between 31 and 40 years of age.

In 216 " or 36%, the disease was discovered between 41 and 50 years of age.

In 150 " or 25%, the disease was discovered between 51 and 60 years of age.

In 44 " or 7%, the disease was discovered between 61 and 70 years of age.

In 2 cases the patients were over 70 years of age.

The statistics of other authors are very similar to these. Thus Sir J. Paget found that of 400 cases, 98 appeared before the age of 40, or 24.5 per cent, and 302, or 75.5 per cent, after that age.

From these facts it is clear that only three out of every ten cases of carcinoma attack the breast of women during the period of its functional activity, that is, before the age of 40; seven cases out of every ten occur in the breast gland during the years of its functional decline, that is, after the age of 40; the decennial period between the ages of 41 and 50 being the one in which the disease is the most prone to appear. The conclusion is clear that in exceptional cases the disease may appear early or late. Independently of the cases analyzed I have seen one which appeared at the age of 96, in the

breast of a lady who had had many children, and died from old age; and a second which was discovered at the age of 86. Mr. Ashhurst saw one at the age of 89.

Social Condition and Fecundity of Patients.—Of the 600 women who had carcinoma, 485, or 80 per cent of the whole number, had been or were married; 115, or 20 per cent, were single. Baker's statistics are about the same: 77 per cent were or had been married, and 23 per cent single. Gross, on the other hand, out of 688 cases, found the married bore the proportion to the single of 88 to about 12 per cent, the proportion of single being less than my own tables show.

Of the 485 women in my own table who were or had been married, 360 were prolific, or 74 per cent, and 125 sterile, or 26 per cent. A large proportion of the prolific women were so to an extreme degree, ten and more children to one mother being a common note to find recorded. Winiwarter has noticed this same point, six children in his cases being frequently recorded to one mother. The breasts of married women and of those in whom the gland has been the most active are apparently more liable to cancer when the period of gland activity has passed than are the breasts of single women. A gland that has been functionally active being more prone in its period of obsolescence to become the seat of carcinoma than another which has never been called into activity.

The above facts show how erroneous is the common assertion that the unmarried women are more liable to carcinoma of the breast than the married.

Breast Involved.—In 300, or half of the 600 cases, the right gland was the seat of disease; in 272 the left; and in 28 both glands were involved; double cancer being apparently present in 5 per cent of all cases, or in 1 in every 20.

Influence of Menstruation.—My own facts are not clear enough upon this point, but Birkett, who is known to be a very careful observer, states, "that in a large majority of the women who have cancer of the breast the function was persistent at the moment of the development of the disease." That is, in 70 per cent of his cases the catamenia were persistent, and in 30 per cent it had ceased. Gross states that in his cases 61 per cent of the women were menstruating, and in only 6.4 per cent of them was there irregularity in the

performance of that function. In 39 per cent the catamenia had ceased.

Winiwarter does not believe that menstruation has any etiological connection with carcinoma, and in this I quite agree.

Duration of Disease when first Seen.—This point was noted in 504 of the 600 cases.

In 221 the disease had existed under a year.
In 165 it had been discovered between 1 and 2 years.
In 39 it had existed between 2 and 3 years.
15 per cent over 3 years.
In 25 it had existed between 3 and 4 years.
In 22 it had existed between 4 and 5 years.
In 15 it had existed between 6 and 7 years.
In 10 it had existed between 8 and 9 years.
In 7 it had existed from 10 to 20 years.

From these facts it is clear that in three out of four cases of carcinoma of the breast the disease when first seen by the surgeon has usually existed for less than two years. In the fourth case it has existed from two up to twenty years. In the majority of these latter cases, and in all those that had given a history of more than four years' duration, the disease was probably of the atrophic kind. I should not, however, have believed, if I had not made the above analysis, that so large a proportion of the cases of carcinoma of the breast of which I had taken notes had been of so chronic a nature as these facts indicate, for it is to be remembered that these figures give the duration of the disease before treatment, and if the benefit of treatment is added, a considerable extension of time would probably have to be given.

If we accept Paget's conclusion, that the average duration of life in carcinoma of the breast is about four years, and my own cases confirm this view when thus divided, we must accept as equally true a more important and hopeful conclusion, that a large number of patients, approaching a third of the whole number, survive this period for months or years. This conclusion will be very palpable on looking at the following table, composed of an analysis of 72 operation cases, the results of which I have been able to trace.

Table showing the duration of life of 72 cases after the car-

cinomatous tumor had been discovered, all of which had been operated upon with success.

In 8, or 11%, the disease ran its course within 12 months.
In 16, or 22%, patient died between 12 and 24 months.
In 16, or 22%, patient died between 24 and 36 months.
55.5% died within three years.
In 10, or 14%, patient died between 3 and 4 years.
In 2, or 2.7%, patient died in the fifth year.
In 8, or 11%, patient died between 5½ and 6 years.
In 2 or 2.7% patient lived eight years.
2 lived nine and 6 ten years, or 14% over six years.
44 per cent over three years.

55 per cent of the whole number sank within three years, and 44 per cent over three years; these proportions being precisely those brought out by Sir J. Paget in his analysis of cases which had not been interfered with. But my table tells us likewise that 18 out of the 72 cases, or at least one-fourth of all cases operated upon, lived from 5 to 10 years.

It is well, therefore, to have this fact always before us, and that whilst we assert in all truth that one-half of our patients will die within the three years, we can with equal justice lead any individual patient to hope that her chances are equally good to live from 5 to 10 years. Indeed, we may with a clear conscience admit, that whilst one-third of all cases die within two years, two-thirds will live from 3 to 10 years; half of these surviving from 5 to 10 years.

The surgeon, with these facts before him, is therefore justified in placing before any individual patient the same hopeful aspect of her case, and thus giving encouragement where so much is needed.

I quote Paget's table of 61 cases, the records of which were complete, since it deals with cases which have not been interfered with, whereas my table includes only cases after operation.

34 cases under 3 years, or 55 per cent:
7 died between 6 and 12 months.
7 died between 12 and 18 months.
8 died between 18 and 24 months.
10 died between 2 and 2½ years.
2 died between 2½ and 3 years.

27 cases over 3 years, or 46 6.2 per cent:
12 died between 3 and 4 years.
6 died between 4 and 6 years.
3 died between 6 and 8 years.
1 died between 8 and 10 years.
5 died between 10 and 20 years.

Baker gives the average duration of life 43 months; Sibley makes it 32 months; Gross only 27 months without operation, and 39 months with.

Carcinoma of the Breast Complicated with Pregnancy.—Should the breast of a pregnant woman be the seat of cancer, the disease as a rule will progress rapidly, and should the stage of suckling be reached, its increase will be still more rapid. These cases are happily rare. I record a few examples.

Mr. Annandale reports that he once operated upon a mother and daughter for scirrhus of the breast, both within two weeks; the daughter was nursing when the disease first showed itself, and in her case its progress was much more rapid than in the case of her mother; and further, the disease returned in the daughter's breast much earlier than in the mother's.

CASE I.—Extensive cancer of breasts and integument of the chest and abdomen, associated with pregnancy following suppuration of breast; death in eighth month of pregnancy.

Mrs. M., aged 35, the mother of nine children, and the first eight of which she suckled, came to me in 1868, when she was four months pregnant, with the right breast and skin over it, as well as the integument of the chest, side, and abdomen, generally infiltrated with carcinoma. In fact, she was skin-bound. The breast with the skin in several parts was ulcerated. The right axillary glands were enlarged, and the right arm œdematous from venous obstruction. The disease in the right breast had appeared as a lump in the gland, which was left after an abscess that formed when suckling her eighth child two years previously. The left breast was likewise infiltrated with carcinoma, and this had followed an abscess after the ninth child, ten months previously.

This patient died from asthenia about the eighth month of her pregnancy.

CASE II.—Cancer of breast, followed by pregnancy, and miscarriage; after which rapid growth of disease; death.

Mary L., aged 44, the mother of four children, all of whom she suckled, came under my care on January 19th, 1865, with carcinoma of her left breast. The disease had been coming for two years, and had increased slowly; seven months ago she became pregnant, since then the disease has progressed more rapidly; she miscarried at the fifth month, that is, seven weeks ago.

At present the mammary gland as a whole is infiltrated, and fixed to the pectoral muscle; the skin over the gland is fixed, puckered, infiltrated, and ulcerated around the gland; in the skin are many small tubercles of cancer; the axillary glands are slightly enlarged. Later on the ulceration spread fast, and the tubercles multiplied over the skin and on the right breast. In September the patient died with chest complication. Her paternal grandmother had died, aged 87, with chronic cancer of the breast; her paternal aunt also, with the same disease, aged 65.

CASE III.—Cancer of breast coming on during pregnancy; acute progress involving both glands; early death.

Eliza S., aged 49, the mother of three children, whom she did not suckle, the youngest being four months old, came to me on March 18th, 1869, with a lump in her right breast, which she had discovered three months before her last confinement, and which had rapidly increased. When seen seven months after its appearance, the whole gland was infiltrated with disease and the skin over it was brawny. The tumor was fixed to the chest; the axillary glands enlarged. There was pain down the arm, which was œdematous.

Four months later the disease had affected the opposite breast, and the woman soon sank. The patient's mother had died from tumor, and her sister from cancer of the breast.

CASE IV.—Cancer of breast with retracted nipple, which prevented suckling, following labor.

Mary B., aged 38, the mother of five children, the youngest being five months. She had suckled all with her right breast, but not with the left, as the nipple was retracted.

November 4th, 1869. The left breast was infiltrated with cancer, associated with enlarged axillary glands. It had com-

menced after her last confinement, five months previously. Six months later this woman died.

Case V.—Acute brawny cancer of breast, appearing during lactation.

Eliza W., aged 35, the mother of four children, the youngest being fifteen months, all of whom she had suckled, came under my care in January, 1871, with infiltration of the left breast and a brawny condition of skin over it. The disease began three months before, during suckling, as a lump which rapidly grew. The skin over the right breast was mottled and was already becoming infiltrated in lines, probably lymphatic. On March 2d the woman was sinking. Her mother's cousin had cancer, and two cousins, one paternal, and one maternal, had tumors.

General Condition of Patient the subject of Carcinoma.

An old prejudice still exists in favor of the presence of a cachexia in cases of cancer; although a very little clinical experience is wanted to learn that this prejudice is wrong, and that there are few patients admitted into metropolitan hospitals with a more general healthy aspect than those who have cancer of the breast. At least half the cases who have this disease present the appearance of perfect health. Two-thirds of the remainder look as healthy as the bulk of those who are doing the work of life well. Whilst in the sixth, not included in either of these classes, some general evidence of illness may be made out; the general evidence depending more upon mental anxiety and apprehension than any real influence of the disease upon the functions of the body. To see what is known as cachexia, the surgeon must go into the cancer wards of a hospital, in which the sufferers from cancer are retained until the end, that is, until life is slowly sapped by hemorrhage, discharges, pain, and the interference with some one or more of the important functions of the viscera from metastatic or secondary growths. These patients look ill and cachectic, it is true, but probably not more so than others who are suffering in an allied way, though not from cancerous affections. The cachexia of cancer, in fact, differs in no way from that of any other exhausting disease. When it exists it indicates the presence of some affection which is undermining the patient's strength, which may be cancer, but it may be any other form of disease.

The observations of other writers support these conclusions, for Gross states that fifty-one per cent of his cases were in good health, nineteen per cent were pale and thin, and twelve per cent were decidely broken down from the effects of the disease. He adds also that the nutrition of scarcely one in twenty suffers previous to sixteen months after the detection of the growth. Paget found that sixty-six out of ninety-one cases presented the characters of good health; nine were in but moderate health, and only sixteen were sickly.

Heredity in Cancer.—Out of my 600 cases of cancer, although carefully inquired into, I found it to exist in only seventy-three cases, or 12 per cent of the whole number. In fifty-four of these, cancer was reported to have occurred in one member; in sixteen in two members, and in three in three members. In fourteen of the seventy-three cases the relation was on the father's side; in thirty-five on the mother's side, and in eleven it was found among the brothers and sisters. In seven of the thirteen remaining cases it had attacked the aunts, in five the cousins, and in one the grandmother, my notes not stating whether maternal or paternal relations. These facts are enough to indicate that an hereditary tendency to cancer of the breast is by no means the rule (only 12 per cent), and that where it exists it seems to be more powerful on the mother's than the father's side.

Gross found a history of heredity in but 9.7 per cent; Paget in 33 per cent; Nunn in 29 per cent. Birkett is unable to support the argument of heredity. Nunn has, however, pointed out a fact of interest, and that is the longevity of the families of patients who have cancer of the breast. He found in 169 cases, that the average age of the fathers was sixty-two, and the average age of the mothers was sixty-one. That 106 of the patients had had grandparents who had lived over seventy years of age; sixty-two had parents who had passed the great age of eighty, and fifteen who had lived over ninety years of age; these facts neither suggest that cancerous patients come from a feeble stock, nor that they inherit the affection, but rather that the disease is an acquired and a personal one.

I may quote here a rare case of carcinoma which existed in mother and daughter at the same time.

CASE I.—Carcinoma of the breast in mother and daughter; of slow growth in the mother, acute in the daughter; in the latter it had followed a blow.

In 1878 I saw Mrs. S., who was then 68, with carcinoma of the cicatrix of a wound which had been made thirty years previously for the removal of a cancerous breast of five years' growth. She had remained well after the operation for twenty-five years, when a return took place. When I saw her there was a tubercle the size of a walnut in the scar, with many other tubercles scattered in the skin over the sternum and opposite breast. Nothing could be done for her. She, however, brought her daughter to me, who was 50 years of age, with a decided carcinomatous tuber the size of a small orange in her breast, which had followed within a few weeks of a blow. The breast was wholly infiltrated, with the skin over it, as were also the lymphatic glands of the axilla and above the clavicle. Nothing could be done for this trouble, and the patient died within six months from probable internal thoracic cancer.

"When," says Darwin, "amongst individuals, apparently exposed to the same conditions, any very rare deviation, due to some extraordinary combination of circumstances, appears in the parent (say once among several million individuals), and it reappears in the child, the mere doctrine of chances almost compels us to attribute its reappearance to inheritance. Every one must have heard of cases of albinism, prickly skin, hairy bodies, etc., appearing in several members of the same family. If strange and rare deviations of structure are really inherited, less strange and common deviations may be freely admitted to be inheritable. Perhaps the correct way of viewing the whole subject would be to look at the inheritance of any character whatever as the rule, and non-inheritance as the anomaly."

If Paget's statement be true, as I take it to be, "that a mark once made on a particle of blood or tissue, is not for years effaced from its successors," why should we wonder at inherited tendencies in form and feature, in physiological function, and in pathological processes: why, indeed, should we not rather expect these inherited proclivities of tissues to have a greater effect, and look for more marked evidence of heredity in disease than we find to be the rule in practice?

The inheritance of a predisposition to disease is a very different thing to the inheritance of a disease itself. The former need never be made manifest; indeed, it is probable that, if it exists, it can be made to perish by the careful exclusion of all such influences as may bring it to light.

Causes of Carcinoma of the Breast.—All evidence tends to show that carcinoma of the breast, as of other parts, is in its origin more a local than a constitutional disease, and that it becomes a general one in a secondary way by what has been described as "local infection," "lymphatic infection," and "vascular or secondary infection."

To start in the breast, as elsewhere, some local source of irritation is required, and that local source may come from without in the form of an injury; or from within, either as some spurious functional activity, or degenerating involution change, or as some antecedent inflammatory change, which as an acute affection may have damaged, or as a chronic one may have irritated tissue.

It is now a recognized fact that persistent irritation of the skin may give rise to an epithelioma, and daily experience supports this view, particularly in disease of the lip, tongue, and penis. The growth of an epithelioma in the bladder of a man, who for years relieved himself by the frequent passage of a metallic catheter through a perinæal fistula, at a spot against which the catheter impinged, is an interesting illustration of this view. The irritation of soot as a cause of sweeps' cancer, and the irritation of common warts, are more familiar examples. The fact also that cancer primarily is most prone to attack the mucous canals at their narrowest parts, where friction is most felt, supports this view.

Persistent local irritation of an epithelial structure is consequently likely to produce a local cancer, and when this local irritation takes place in a gland, such as the breast (which is undergoing involution changes and becoming obsolete) the tendency to produce a carcinomatous tumor is increased; when, in addition to these local causes, there is added the predisposing influence of heredity, by which the members of a family tend to resemble not only their immediate parents, but to comprise in themselves the foibles of several generations, the pernicious influence of a local irritation is likely to become rampant.

That new tissues, such as cicatrices, are prone to become the seat of epithelioma, is well recognized; there is, indeed, no denying the fact that the cicatrices of burns, of old ulcers and stumps, are constantly the seats of cancerous disease, and more particularly when irritated; we need not, therefore, be surprised that epithelial gland structures, such as the breast, should occasionally become the seat of epithelial growths, after having been injured by some chronic or even suppurative inflammation; the carcinomatous disease not following at once the local affection which first injured the breast tissue, but attacking it, as it might a scar, at a more advanced period of life, the reparative material in the gland and in the scar being both new, and in a measure cicatricial. I have seen a cancerous tumor originate in the scar of an antecedent breast abscess, and many carcinomatous tumors have followed a previous mastitis.

Gross states that carcinomatous disease started from lumps, or chronic indurations left by puerperal mastitis in 8.21 per cent of the 365 women who had borne children; the lumps left by the mastitis having remained quiescent for a period which varied from four to twenty-eight years. My own statistics tell me that out of my 360 cases of women who had borne children, mastitis had occurred at some antecedent period in eighty, but it is almost impossible to make out that the cancerous tumor originated at the seat of scar or induration. The tumor in the majority of instances appeared many years after the mastitis; in one case thirty years.

In the following case carcinoma clearly originated in the scar of an operation made twelve years previously for a cystic non-cancerous tumor:

Case I.—Cystic degeneration of the breast, with enlargement of one of the cysts, and the development of an intracystic adeno-fibromatous growth; removal of the growth; twelve years later carcinoma of the cicatrix.

A healthy widow, aged 30, with one child ten years of age, consulted Mr. Birkett in October, 1859, for a small painless swelling, situated in the clavicular lobe of her left breast, which had been growing for seven months. The tumor was in a measure pear-shaped, with its narrow end near the nipple, nodular, and elastic. Pressure upon it caused a few drops of

a clear, yellow, viscid, albuminous fluid, to exude from the nipple, which was natural. The axillary glands were not enlarged. In December, 1859, the tumor was excised with some of the breast gland, and the patient recovered. On section the tumor was found to be formed of a cyst, which contained serum, and communicated with a duct near the nipple. Throughout the tissue of the lobe removed, and of the gland structure exposed by the incision, were small cysts, containing intracystic growths. There was no distinct, well-marked, limited envelope around the tumor, but the cyst and all the new growths were so closely identified with the ordinary tissue of the breast, that it was absolutely necessary to cut its structure in order to remove effectually the whole of the tumor. The intracystic growths were composed of the cæcal terminations of gland tissue and fibre elements, the former loaded with epithelium.

The patient remained well for eleven and a half years, when a carcinomatous tubercle appeared in the scar, which enlarged and ulcerated. In June, 1872, it formed an excavated ulcer, with thick everted edges one inch and a half in diameter; the axillary glands were enlarged. October 15th, 1872, the breast and growth were removed, the patient recovering.

Direct injury is, without doubt, a common cause of tumor formation, although not particularly of carcinoma. To say in what proportion such cases occur is difficult, and I am unable to add any statistical evidence upon the point, beyond that in two-thirds of my cases the disease was attributed by the patient to some such cause. Gross states that in 11.7 per cent, or 23 out of 270 cases analyzed by Winiwarter and himself, the disease was attributed to injury, as blows or contusions.

In the following case the cause and effect seem to be closely connected:

CASE II.—Carcinoma of the breast in an old woman, aged 71, following a blow; it was ulcerating, and on that account was removed, and with good success.

Susan C., aged 71, came under my care in October, 1880, with an ulcerating carcinomatous tumor in her right breast, which had appeared within a few days of a blow she had received in the part ten months before admission. Two months ago this tumor had broken down and discharged. When seen

a carcinomatous tumor occupied the upper half of the gland. The skin over it was infiltrated and ulcerated. The nipple was retracted. Axillary glands not to be felt. The breast was removed, as the ulcerating surface was a source of distress and weakness, and the patient did well. The temperature after the operation never rose above 99°.

Eczema or ulceration of the nipple, as a precursor of cancer, is now a recognized cause, since it was pointed out by Paget, in the tenth volume of St. Bartholomew's Hospital Reports, published 1874, although in what proportion of cases the nipple trouble and the breast disease are associated is not yet evident. That eczema of the nipple may exist and get well, without giving rise to a cancer, is a clinical fact, as is likewise the formation of a cancerous tumor after the long existence of the nipple trouble.

Paget, in his paper, quoted fifteen examples, and described the disease as having "the appearance of a florid, intensely red, raw surface, very finely granular, as if nearly the whole thickness of the epidermis were removed; like the surface of very acute diffused eczema, or like that of an acute balanitis. From such a surface there was always copious, clear, yellowish, viscid exudation. In some cases the eruption has presented the character of an ordinary chronic eczema or psoriasis, the eruption spreading beyond the areola in widening circles, or with scattered blotches of redness covering nearly the whole breast. The eruption has resisted all treatment, both local and general, and has continued even after the affected part of the skin has been involved in the cancerous disease."

Butlin has added to this classical description of the local disease, as seen at the bed-side, some histological information, and has shown us how, as he believes, the carcinoma becomes a consecutive disease to the nipple affection.[27] "The activity and proliferation of the epithelium of the nipple is continued into the mouths of the galactophorous ducts; the same activity and proliferation can be traced along the ducts, in which the form of the cell is usually changed, and a spheroidal cell is substituted for the columnar cell, which naturally prevails there; these morbid conditions are continued deep down into the substance of the mammary gland, where the sacs become similarly affected."

"Coincident with the changes in the ducts and glandular epithelium, increased vascularity and the collection of cells resembling leucocytes are observed in the connective tissue immediately surrounding the glandular apparatus. But no direct connection can be traced between the changes within the ducts and sacs and those without them, and the latter are subordinate in character and degree to the former. Not until the disease is advanced, and a definite tumor has been formed, which can be recognized with the naked eye as carcinoma, are cells resembling those within the ducts and sacs found in the surrounding tissues."

At a later stage of the disease the ducts and acini of the gland will be found filled with proliferating epithelium, which eventually escapes from the ducts by rupture or growth into the surrounding tissues, thereby producing the full formation of carcinoma.

Dr. Thin,[28] who made a minute examination of the skin of the nipple and breast tumors in four of these cases, two of them having been subjects of operation by Mr. Henry Morris, one by Mr. George Lawson, and the other by Mr. Manby, of East Rudham, has taken a different view as regards the nature of the skin affection. In two cases of the disease which he had an opportunity of examining before operation, the clinical evidence was, in his opinion, against eczema, and in favor of an infiltration in the superficial layer of the cutis. Microscopical examination he considers to be decisive on this point, proving that the disease is not an eczema, the destruction of the cells of the epidermis and the breaking down of the bundles of white fibrous tissue in the papillary layer of the cutis being in excess of the changes which are found in cases of eczema. In distinguishing clinically this malignant dermatitis from eczema, Dr. Thin considers that the chief points to be borne in mind are the well-defined margin in the former, and the evidence, when the tissue is grasped between the fingers, of infiltration in the papillary layer. In two cases which came under his notice there was clear evidence that the disease began in a position corresponding to the openings of the galactophorous ducts, and remained limited in that position for some time before extending over the surface of the nipple. He considers the infiltrated condition of the areola, which in some of its features is so suggestive of eczema, to be produced by the

action on the connective tissue of a fluid which escapes from the mouths of the ducts, and which possesses the corrosive qualities of cancerous epithelium. He believes that the first morbid change is really a cancerous change in or near the mouth of the ducts, and that the so-called eczematous conditions are secondary to these changes. In all the four cases examined by Dr. Thin the cancerous tumors were of the variety appropriately termed duct cancer, the cancerous epithelium taking its origin not in the acini of the gland but in the epithelium of the ducts; the fibro-carcinoma cysticum mammæ of Waldeyer.

Dr. Munro[29] relates three cases bearing on this disease. In regard to one of them, he states that it is his firm belief that the primary sore was from the very commencement malignant disease of the epithelium at the mouths of the galactophorous ducts, and that the supposed induced or secondary disease in the breast stands in the same relation to the disease as the more distant glandular deposits.

Dr. Duhring[30] relates two cases which, he believes, show "that the disease is not an eczema, but that it is a peculiar disease with a malignant tendency." He remarks that in his two cases nothing of a malignant nature was suspected until after the lapse of five and ten years respectively, and that itching was in both cases insignificant until the affection had existed several years, in this respect the disease differing decidedly from eczema, where itching is one of the first signs noted. In regard to the clinical features, Dr. Duhring corroborates the description given by Dr. Thin. The circumscribed, sharply-defined lesion, and the slightly elevated border, are symptoms which, he states, do not obtain in eczema. "The brilliant color of the lesion is striking and is more marked than in eczema, the absence of the eczematous surface characterized by an appreciable discharge, or by vesicles, pustules, or puncta coming and going from time to time, and the absence of exacerbation so usual in eczema, may also be referred to." A point to which he also directs attention is the infiltration, "which is firm or even hard, but is not deep-seated. It is rather superficial. In eczema, on the other hand, it is soft."

This local disease, if eczema or otherwise, is therefore neither to be treated lightly nor disregarded, and the thought that it will eventually lead to, if it be not from the first, cancer, should be a prominent one in the surgeon's mind.

In most of the cases recorded, the nipple disease had preceded the breast disease from two to five or six years.

Gross and Oldekop's tables show that this eczema of the nipple preceded the carcinoma in 5, or 1.35 per cent, of 370 cases. Mr. Henry Morris[81] records two out of 305 cases. I have recorded but three examples in my 600 consecutive cases. I quote these three with others that I have extracted from my note-book.

CASE I.—Carcinoma of breast, preceded by serous discharge from, and eczema of, the nipple; operation; convalescence.

Martha C., aged 33, came under my care in January, 1880, with a tumor occupying the upper half of her left breast, which had been growing for one year, with infiltration of the skin over it; there was likewise a local patch of eczema involving the areola, and half the nipple, which is retracted. She had, for some weeks before the tumor was discovered, a discharge from the nipple, and some scabbing at its apex. The axillary glands are enlarged.

The breast, tumor, and glands were removed with a good result.

CASE II.—Carcinoma of the right breast, following eczema of the nipple; excision of tumor, which was a typical duct cancer; cure.

Jane G., aged 53, a healthy woman, the mother of several children, all of whom she suckled without difficulty, came under my care on January 28th, 1887, with a tumor in her right breast.

It had appeared four years previously, in 1883, as a small lump, the size of a pea, on the outer half of her right breast. It gave no pain, and she disregarded it. In August, 1885, the nipple became sore, and she sought advice. Some application was applied to the nipple, and the eczema improved, but never got well. The lump in the breast during this time had much increased. When admitted under my care into Guy's Hospital there was a patch of eczema, about the size of a florin, occupying the site of the right nipple, which had become obliterated. Behind and to the outer side of the eczematous patch there was a hard nodular tumor, measuring three inches transversely and about two inches vertically, in the substance

of the breast. The skin over it was not implicated, and the tumor moved with the breast freely over the deeper structures. It was not painful. An enlarged gland could be felt in the axilla.

On February 5th the tumor on the breast and its axillary glands were removed, and a rapid recovery took place.

Mr. Targett, the surgical registrar and pathologist, examined the tumor, and gave the following report: The microscopic examination showed the changes of chronic eczema in the nipple and areola. There was proliferation of the epithelium along some of the ducts and especially in the terminal acini. In the latter situation there was much small-cell infiltration around groups of acini, and in this manner they were converted into the alveoli of fully developed carcinoma. It is thus a good example of duct cancer following on chronic eczema of the breast.

CASE III.—Eczema of nipple; cancer of breast.

Elize S., aged 62, who had been married 35 years, and had 6 children, came to me on February 19th, 1865, with an infiltration of the upper lobe of her right breast, which had existed for one year. For two years previously she had had eczema of her nipple, and during this time the nipple projected; for three years before the eczema appeared it had been retracted. In June, 1865, the skin over the breast was infiltrated with cancerous tubercles. I then lost sight of the patient.

This patient's mother died from cancer of the breast, and two of her brothers of internal cancer.

CASE IV.—Paget's disease of nipple, followed by carcinoma; destroyed with cautery.

Mrs. B., aged 60, a married, childless women, came to me March 26th, 1877, with eczematous ulceration of the right nipple and areola, of four years' standing. The nipple had gone, and much of the areola. The surface was ulcerated, but not thickened. Total destruction of the whole surface with a cautery was carried out, and the parts healed. Some months later the hardness reappeared, and ulcerated, and in 1879 the right breast was excised, and convalescence followed; but the disease soon returned and, invaded the opposite breast. The patient died in 1882.

CASE V.—Carcinoma of breast following eczema of nipple.

Miss S., aged 57, consulted me in May, 1875, for an eczema

of her nipple which had existed for many months. When seen by me there was marked infiltrating carcinoma of the breast; retracted nipple and a red raw surface in the position of the nipple and its areola.

Operation advised, but refused.

CASE VI.—Carcinoma of breast following eczema of nipple.

Mrs. S., aged 45, the mother of five children, came to me in October, 1877, with an eczema or rawness of one nipple of two years' standing, following by swelling, hardness of the breast, with retracting nipple. This increased for nine months, and then ulcerated. When seen there was an open cancerous ulcer of the breast and nipple. Her mother is said to have died from cancer of the face.

Operation advised, but refused.

Mental anxiety as a cause of carcinoma must not be omitted, although to adduce proof of the truth of the proposition may be difficult; to say that it is an antecedent of many cases of carcinoma is, however, a fact which the experience of most surgeons would support. The late Mr. Charles Moore was a firm believer in its influence.

On the Influence of Locality in Cancer.—It is impossible to deny the influence of nationality and of geographical position upon the frequency of cancer. For in some countries little of it is seen, whereas, in others, it is met with frequently in certain districts, and in others but rarely. In Turkey, Greece, Syria, Persia, North Africa, and Iceland, it is very rare, whereas in parts of India and China it is more common. In Europe its relative frequency is very curious, and Hirsch tells that it varies from nearly 10 cases in 10,000 inhabitants, as met with at Trondhjem in Norway, and in Lombardy in Italy, to 2 in 10,000 in Sardinia. In America the death rate is about 4.5, and in England much the same, the rate apparently in our own land having increased during the last few decades; that ending 1859 having been 3.3, and that ending 1876 4.6 per 10,000. In all these statistical figures it may be fairly assumed that in women half the cases are affections of the breast and uterus.

Lastly, as one of the causes of cancer, and consequently of cancer of the breast, is the geographical distribution of the disease. Dr. Haviland having demonstrated by means of a

cancer chart collated from the records of the Registrar-General, and read before the Society of Arts in 1879, that there are certain localities in England in which cancer predominates largely over others, and he certainly has shown that these cancer fields lie along the low-lying alluvial beds of river courses, and the geological strata of the tertiary formation. "Cancer fields," he wrote, "are situated along rivers that occasionally overflow their banks."

Hirsch, however, is no believer in this theory or explanation, for he reminds us that in Norway, cancer occurs mostly in the mountainous districts, and at considerable elevations; also that in Mexico the high table-land is more subject to cancer than the low places.

By way of summary as to the causes of carcinoma, the following conclusions seem just:

1. That there exists in those who manifest the disease, and probably in many others who never live to do so, a predisposition to its development under any exciting cause.

2. That this predisposition is, to a degree, due to heredity, although sufficient evidence exists to suggest that the predisposition may be strengthened, or even acquired, either by long residence in low-lying districts in which rivers are prone to overflow their banks, or by the long-continued depressing effects of mental influences.

3. That the disease is, under all circumstances, primarily a local one, originating in a gland or tissue that has been the seat either of a direct injury, or that has undergone some degenerative change, the effects either of age, obsolescence, or some antecedent spurious functional activity, inflammatory action, or persistent local irritation.

CHAPTER XIII.

THE CLINICAL FEATURES OF A SCIRRHOUS CARCINOMA.

WHEN a cancerous tumor has fully developed, and more particularly the first two varieties, it has features of so marked a character that its nature can hardly be misunderstood. When it is developing, its early features are ill defined and uncertain, consequently a positive diagnosis of its nature is difficult if not impossible; and yet it is at the very early stage of the disease that a diagnosis is most essential, since it is then, if at all, that a cancer may be regarded as a local and consequently as a curable affection.

It is to be remembered that in the majority of cases of carcinoma of the breast, the disease attacks the breasts of women about forty years of age when the procreative organs are verging toward their natural period of functional decline; and when the breast as a gland is either obsolete, or is passing into the stage of obsolescence. It is, however, found in younger, as well as in older subjects; when in the younger it usually appears as an acute or active affection, when in the latter as a more chronic one.

Early Local Symptoms of Carcinoma.—In the majority of cases when discovered it appears either as an ill-defined thickening of one of the lobes of the gland, or as a nodular swelling fixed closely to the tissue of the breast. It is generally found out by accident, as in washing, and the attention of the patient is rarely drawn to the part by pain; should pain be present it will generally show itself as an occasional shoot of pain, although sometimes as a sensation of heat.

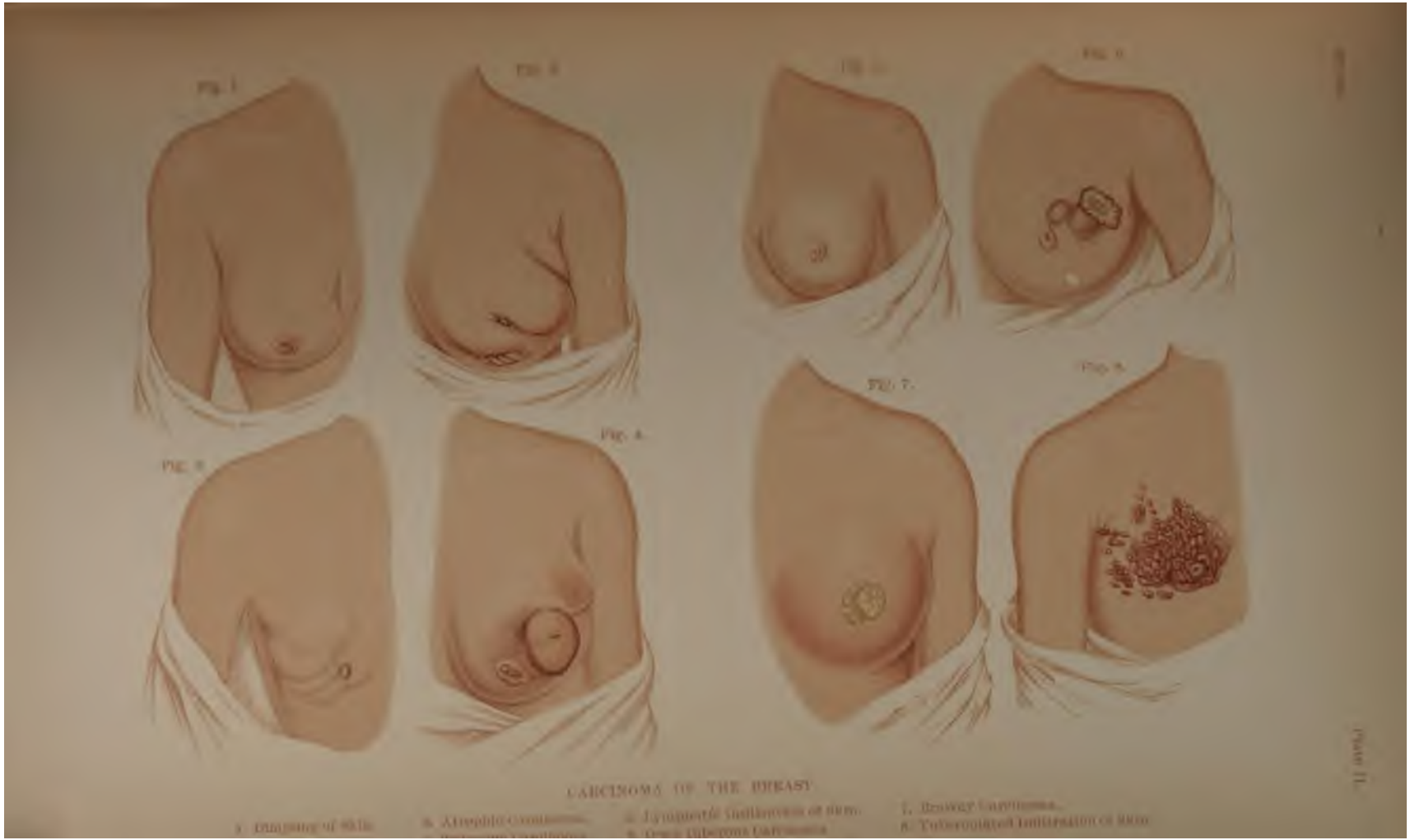
With these early symptoms present, how is a diagnosis to be made; for what affections may the disease be mistaken? A few words upon these questions may be of value.

Should the disease appear as a mere thickening of one of the lobes of the breast, this clinical fact is one which of itself

should excite the apprehensions of cancer; for the thickening can only be brought about by one of two causes, either carcinomatous infiltration, or chronic inflammatory infiltration; and it must be admitted that too often to the touch these two forms of infiltration yield the same sensations. In cancer, however, in a large proportion of cases, the hardness is of a stony, unyielding character, and the examination, if not rough, is well tolerated; while in the chronic inflammatory condition the induration is fleshy and somewhat yielding, the same amount of manipulation likewise evokes pain. In the chronic inflammatory trouble there will likewise probably be more pain on gentle manipulation than is usually met with in cancer, and after examination the patient will show some signs of excitement or irritability. In this latter trouble, also, more than one of the lobes of the gland will probably be found coarse and knotty, although but one may be tender, and possibly the opposite gland will be equally affected.

In cancer, in brief, the disease starts in one lobe of a gland, and as an indolent swelling it is rarely associated with any signs or symptoms of local inflammation, such as may be made out in the chronic lobular inflammation of the breast, which is prone to attack women at the climacteric period. Cancer in its early stage is known more by the absence of symptoms than by anything more definite, by a painless, or nearly painless local, stony infiltration of a part. This stage of cancer may be described as the "early infiltrating stage." When the disease first shows itself as a nodular swelling fixed closely to the tissue of the breast, the same thought of carcinoma should be excited, but at the same time the possibility of the lump being due to the presence of an involution cyst should not be forgotten. The rounder the lump, the greater the probability of its being cystic; the more irregular and nodular the swelling, the greater the probability of its being cancerous. A hard, nodular swelling is more likely to be cystic than inflammatory, and it is at least as likely to be cystic as cancerous. For diagnosis an exploratory puncture with a needle is frequently demanded; or what is better, an exploratory incision.

As the disease advances, and reaches the stage which, for descriptive or clinical purposes, may well be called the "mature infiltrating stage," the diagnostic points become more marked.



CARCINOMA OF THE BREAST

1. Diagram of skin.
2. Atrophic Carcinoma.
3. Lymphatic Gadinoma of skin.
4. Open tubercular Carcinoma.
5. Recent Carcinoma.
6. Tuberculated Infiltration of skin.

The induration of the lobe primarily involved has become more evident, and it has probably spread from its early position in a single lobe, either to a neighboring lobe or to the soft parts covering the lobe, and in this way changes will have been brought about in the skin, which are all equally characteristic, and differ only in the degree in which the skin with its subcutaneous tissues is involved. I have been in the habit of describing these changes, as will have been observed by the reader in perusing some of the preceding chapters, under three headings, namely, "Dimpling," "Puckering," and "Infiltration" of the skin, and I believe that this division tends to clearness.

Dimpling of the skin means more or less depression or cupping of the skin covering the infiltrated lobe, brought about by the contraction of the suspensory ligaments of the breast (Plate I., Fig. 1), which pass from the normal capsule of the gland to the skin itself. Where only a few of the ligaments of the gland are involved, the dimpling or cupping of the skin will be limited; where the ligaments involved are numerous, the area of skin depression will be extensive. This condition is well seen in Plate III., Fig. 1. The skin at this stage can, however, be rolled over the growth beneath, or raised from it. This symptom is never present in any connective-tissue tumor of the breast, nor in an inflammatory affection.

The *puckering* of the skin is a later stage than that described, for in it the skin is closely drawn down to the growth beneath, and has practically become a part of it by the process that has been described as local infection. (See Plate II., Fig. 2.)

The suspensory ligaments have contracted to the full, and the skin can no longer be rolled over or raised from the growth. The depression of the skin is now still more marked than it was in the "dimpling" stage, and the surface of the skin presents to the eye a peculiar pitted appearance, which Mr. Banks has aptly described as resembling the pig skin of which a saddle is made. The skin, on manipulation, may feel, to the touch, fairly healthy, or it may seem slightly harder than normal. This condition being suggestive of the next or most diagnostic indication of carcinomatous disease (the stage of local "skin infiltration") in which the skin has become involved by the extension of the disease, by local infection.

In the *infiltrating stage* the skin is not only drawn down and puckered in the ways already described, but it is bound down to the growth beneath, and to the finger feels firm and indurated; the induration being brought about by the infiltration of the skin itself with carcinomatous elements.

The tumor at this advanced stage of the disease seems to be one with the skin; neither in the gland nor in the skin can the surgeon clearly define the boundary of the growth. In fact, it has no definite boundary; for from its central lobular starting place the epithelial elements have spread by infiltration outward in all directions, and drawn all surrounding tissues into its sphere.

In some examples of disease at this stage of trouble the mobility of the tumor will have considerably lessened; what could before have been moved freely with the breast gland upon the extended pectoral muscle, is now somewhat checked in its movements, in some cases to a limited, in others to a marked, degree; the degree of immobility of the tumor and breast gland upon the pectoral muscle below being the exact measure of the amount of infiltration of the deeper tissues, in the same way as the "dimpling," "puckering," and "infiltration" of the skin is an exact measure of the infiltration of the superficial.

To test the mobility of a breast tumor upon the pectoral muscle, it is essential that the muscle should be placed upon the stretch by raising the arm. With the muscle relaxed, a tumor which is perfectly fixed to it may appear movable, the tumor and relaxed muscle moving together. With the muscle extended this fallacy will be avoided.

Retraction of Nipple in Carcinoma of the Breast.—There is no greater fallacy than the very general assumption that retraction of the nipple is an essential symptom of carcinoma of the breast; and no greater error than that with this symptom the diagnosis of cancer is confirmed, and that without it the disease must be of another kind. The truth is that retraction of the nipple is only an accidental symptom of cancer of the breast, met with when the disease is placed near the nipple, but not otherwise; that is, when the disease is so situated that the ducts of the gland are drawn upon by the infiltrating process, and the nipple, as a consequence, is pulled, as it were, toward the infiltrated lobe. When this retraction of the nip-

ple exists associated with a chronic infiltrating tumor of the breast, it is, as a symptom, one of great value; indeed, as great as the dimpling and puckering of the skin over the tumor has been shown to be (Plate II., Fig. 2). By itself the symptom is of no special value, since it may have been a congenital condition, or an acquired one from some antecedent inflammatory or other affection. Again, should the infiltrating lobule be placed at the periphery of the gland, where, by its contraction, the ducts of the gland, as they pass to the nipple, will be but little affected, there will be no retraction of the nipple. Indeed, the nipple may, under these circumstances, be very prominent. The symptom, therefore, is only of value when found in combination with other symptoms; by itself it tells nothing. Again, in some cases the nipple may become retracted during the early stage of the disease, and at a later period become prominent; the disease at an early period of its progress causing traction upon the lactiferous ducts, and at a later period of its course, by steady infiltration, so thickening the gland beneath the nipple, or the nipple itself, as mechanically to lift it out of its umbilical bed and cause it to project. In a third class of cases the nipple may become strangulated at its base by the contraction of the carcinoma, and consequently œdematous, and possibly ulcerated. At a still later stage, from the same cause, the nipple may slough off.

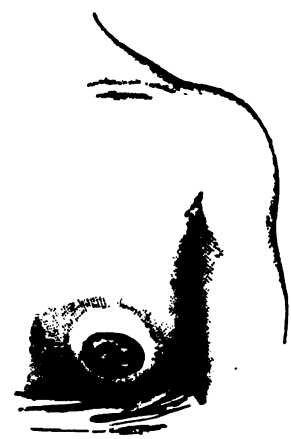


FIG. 4.—Retraction of the Nipple in case of Adeno-sarcoma of a woman, aged 54.

At times a retracting nipple is the first point which draws the attention of the patient to her breasts, and leads to the detection of an early carcinoma.

One of the best examples of retracted nipple I have seen was in a woman past middle life, who had a central tumor of her breast (Fig. 4). The nipple seemed telescopically to be inverted, and to form a depression in the centre of a circumferentially raised fleshy growth. The tumor, when removed, turned out to be an adeno-sarcoma, developed beneath the base of the nipple, in the centre of the breast gland. By

its growth, it had steadily made traction upon the ducts of the gland, and as a consequence drawn the nipple as described. Simple tumors, however, rarely cause this retraction. They may, by their growth, flatten a nipple out, or push it into some out-of-the-way place, but they seldom cause its retraction. Where this symptom is present with a benign tumor, it is due either to the central position of the tumor, or to a congenital or acquired condition, such as a former abscess, or local inflammation.

Discharge from the Nipple in Cancer.—In the carcinoma fibrosum of the breast it is by no means common for the patient to complain of any discharge from the nipple. In exceptional cases this symptom may exist, and in some cases before me a serous or blood-stained discharge had preceded the induration of the breast by some months. In one a serous discharge was the earliest symptom; in another a bloody discharge had existed for six months before any tumor was discovered; in a third case a blood-stained clear discharge had existed for 2½ years before a lump was detected; in the fourth case there had been a porter-like discharge from the nipple for four years before a tumor was recognized. In all these cases, when they came under my care, the disease was clearly of the acute scirrhous form, and unaccompanied with any marked cystic complication.

In a general way when there is much nipple discharge before any solid neoplasm is discovered, the disease has been cystic in its origin, and carcinomatous or sarcomatous secondarily. These cases will, however, receive attention in Chapter XVI., which is devoted to cystic disease.

In the following cases the growth of the tumor was preceded or accompanied by some discharge from the nipple:

CASE I.—Cancer of breast preceded by discharge from nipple.

Jane E., aged 35, the mother of three children, the youngest being eight months old, and all of whom she suckled, came under my care on October 26th, 1867, with induration of her left breast, dimpling of the skin over the breast, retracted nipple for six months, and discharge of blood from the nipple for five months. In January, 1868, the discharge from the nipple had ceased for two weeks, but returned copiously. On

September 3d, 1868, the breast was much larger and harder; the nipple had retracted more; the skin was puckered and infiltrated; no axillary glands were enlarged. Operation was advised, but refused. On July 15th, 1868, the arm was œdematous, and she was sinking.

CASE II.—Carcinoma of breast with imperfect nipple, and early discharge from nipple; operation; recovery.

Sarah N., a married woman, aged 40, the mother of four children, all of whom she had suckled with her left breast, but not with her right, as the nipple was imperfect, came to me in August, 1872, with a general infiltration of her right breast, retracted nipple, puckering of the skin over the tumor, and enlarged lymphatic axillary glands. This disease had been coming on for four months, and attention was first drawn to it by the discharge of a curdy material from the nipple, which could be increased by pressure. The breast was removed and recovery followed. The tumor was of the scirrhous kind, with cystic elements.

CASE III.—Carcinoma of breast; bloody discharge from nipple; operation; well four years later.

Mrs. G., aged 60, no children, for 2¼ years had blood-stained discharge from the nipple and some hardness of the left breast; the discharge could be increased by pressure. January 28th, left mammary gland, nipple, and axillary lymphatic gland infiltrated with carcinoma. All were removed, and patient convalesced. The tumor was of the common scirrhous kind. Four years later this patient was well.

CASE IV.—Scirrhous carcinoma of the breast, associated with discharge of porter-like fluid from a retracted nipple, and followed by tuberculation of the skin and enlarged axillary glands; excision of growth with glands; return of disease in skin and opposite breast; patient was alive four years after operation, or eight years after its first appearance.

Mrs. W., a childless married woman, aged 46, came under my care in May, 1875, with her left breast and skin covering it wholly infiltrated with carcinomatous material, and enlarged axillary lymphatic glands. The disease had been slowly coming for four years, and had commenced as a glandular induration and some retraction of the nipple, the nipple soon discharging freely some porter-like fluid. I excised the breast with the skin over it, and the axillary glands, and a good con-

valescence followed. Three years later some few tubercles appeared about the scar, and these slowly multiplied. In January, 1882, the opposite breast became involved, but the patient's health was good. I then lost sight of her. The disease had existed for eight years when I last saw her, and the breast had been removed four years previously.

Lymphatic Infection.—As soon as the skin has become involved, or the tumor has become fixed to the deeper parts, another stage of the disease has to be noted, with probably another starting point; for about this time the glands associated with the tumor by their lymphatic ducts may be expected to become enlarged, and consequently infiltrated. Indeed, "lymphatic infection" may be expected to show itself as soon as it is clear that the disease has spread from its primary starting point, in whatever part of the breast that point may be, and invaded the connective tissue outside the gland, as evidenced by skin dimpling or infiltration; this stage of the disease according with its entrance into the lymph spaces of the glands, such being the true radicles of the lymphatic vessels. When the glands are perceptible to the surgeon's fingers, this lymphatic infection has evidently advanced far, for in ordinary and not very thin subjects there may be some enlargement of the lymphatic glands of the axilla, or beneath the pectoral muscle, without the fingers of the surgeon being able to detect them. Surgeons are now familiar with the fact that, in an operation, enlarged axillary glands are frequently found where beforehand they were not expected. In very thin people the diagnosis of their presence or absence may with some accuracy be determined. In fat subjects this cannot be said to be the case. To make out the true condition of the glands, they must be searched for by an incision through the skin and fascia. To conclude that they are not enlarged because they are not felt through the integument would generally be an error.

The lymphatic glands in connection with a carcinomatous tumor may, however, occasionally enlarge, and later on diminish and even assume their normal dimensions, just as they are known to do as a result of some inflammatory action of the part with which they are connected. I have seen this occur in carcinomatous breast cases on two very distinct occasions, and do not doubt the fact; and such a condition is by no means

uncommon in other regions, such, for example, as the glands under the jaw in epithelioma of the tongue, or of the groin in penile cancer. The explanation can only be that there was associated with the carcinoma some temporary irritative cause, which gave rise to the lymphatic swelling, which subsided with the cause.

In one case which made a lasting impression upon me, the patient, aged thirty-four, the daughter of a surgeon, had true scirrhus of the breast of two years' standing, without evidence of lymphatic complications. The lady was very thin, consequently her axilla was easily explored. I advised early operation in the case, and during the waiting period the glands suddenly became tender and markedly visible. Her father, under those circumstances, regarded the removal of the breast and glands as unjustifiable, and so let things drift. In two months, under the influence of belladonna and glycerin as a local application, the glands steadily subsided, and when I saw her again they were not to be detected. I then excised the breast, laid bare the axilla to search for glands, which were not found, and the case did well. The patient survived the operation five years, and died from some internal disease, the nature of which was never made out by a *post-mortem*. It was believed to have been liver disease; probably it was carcinoma.

The second case was in a single lady, aged 36, from whom I removed a carcinomatous breast, and some enlarged axillary glands, in 1864. She recovered rapidly after the operation, and remained well for three or four months, when she was brought to me by her medical man for a swelling in the affected axilla, which had been detected about a week. The swelling was clearly glandular, nodular, and the size of a walnut. In three months, when I saw her again, the swelling had decreased under the use of belladonna and glycerin, and a few months later it had disappeared. The lady lived six or seven years longer, and died from some acute lung affection.

As the axillary or other glands enlarge, new symptoms and conditions show themselves; for the enlarged glands must be regarded as fresh centres of disease, which progress precisely in the same lines as the original affection. They increase in size locally, and infect neighboring tissues by infiltration. The lymphatics that pass to and from the glands

become direct channels of communication of the disease, unless they themselves become choked and their walls infiltrated, and thus cease to be tubes. They feel, under these circumstances, as solid cords, and may often be traced in the skin as white tubes, thickened and nodulated (Plate II., Fig. 5). As the glands enlarge, the veins of the axilla, or above the clavicle, become pressed upon, and the venous circulation of the arm of the affected side, and of the side and shoulder, becomes interfered with. Under these circumstances, a more or less rapidly occurring œdema of the part involved is a new symptom. The swelling may be either slow in its formation, or very rapid, this point turning upon the suddenness and completeness of the venous obstruction, and upon the size and position of the vein obstructed. Should the vein be one of small size, the œdema will be limited; should it be the axillary vein itself the œdema will be general and rapid. The arm will enlarge and become congested, according to the extent of vein pressure; at times, from congestion, it may be mottled or purple; in other cases there may even be local static gangrene.

Very often, however, the œdema, which may have set in suddenly, steadily subsides under treatment, by elevation, gentle pressure, and friction directed upward; and when this takes place, it is because the vein has either re-opened, or the blood has found other channels through which it can return to the heart. This improvement is, however, rarely lasting. With obstruction to the veins of the axilla, there is generally pressure upon some of the nerve trunks of the brachial plexus, and as a result pain is produced. The seat of pain is determined by the nerve trunks that are pressed upon; in some of these cases it is severe and most distressing; too often it is of a hopeless character, since there is but little prospect of its being relieved by anything less than the death of the sufferer.

Tuberculation of the Skin (Plate II., Fig. 8).—If there be one symptom more typical of cancer of the breast than another, it is the "shot-like" tubercular infiltration of the skin, which is met with in certain cases of the disease. When this condition is present, there can be no doubt as to the nature of the affection, for in no other disease than carcinoma is the skin ever the seat of deposits, which may be so small as only to be perceptible to the finger when passed gently over its surface, or so perceptible and palpable to the surgeon's eye and hand

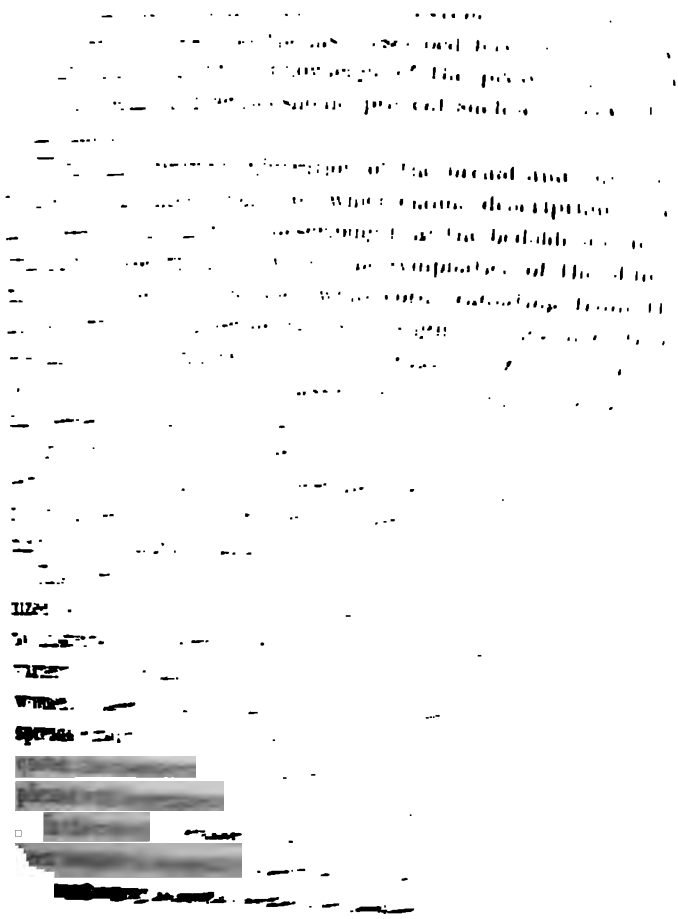
as to show up as small wax drop-like infiltrations of the skin over the deep tumor, as well as over the surrounding parts. In some cases this shot-like infiltration is very local, in others it is more general. In some the skin appears to the eye mottled irregularly red, and to the finger it is irregularly indurated. In other cases the mottling and infiltration are general, and the skin feels universally indurated. Two or three tubercles in the skin associated with a chronic infiltration of a lobe or lobules of a breast, are, however, as typical of a local cancer as a large number.

In exceptional cases these tubercles appear as bloodless indurations of the skin, and then disappear (see case, page 151); a withering atrophic change, apparently due to contraction of the fibrous elements of the growth, so chokes or destroys what little cell structure may have existed in its alveoli, as to be followed by atrophy; the atrophy in some cases shows itself by a steady disappearance of the tubercles, while in others the tubercles crumble away and disappear. During this wasting process there is, however, usually a developing one; and while, on the one hand, tubercles disappear, others show themselves, so that on the whole the disease usually advances. In a third class of cases, again, the tubercular infiltration of the integument may be an acute condition which shows itself in this form from the first, or as a sudden outburst of development accompanying a chronic carcinoma. When these tubercles appear in the skin, the surgeon may fairly assume that they exist in other tissues surrounding the local tumor, and their existence is to be accepted as evidence of local dissemination of the disease.

The Brawny Infiltration and Tuberculation of the Skin.—The tuberculated condition of skin which has been just described is generally met with in the course of development of the chronic fibrous form of carcinoma or scirrhus; but the same condition is met with in that variety of acute carcinoma which may well be described as the brawny. It shows itself either as a rapidly disseminating tubercular affection of the skin, or as an acute œdematous or brawny infiltration (Plate IV., Fig. 3). Under both circumstances the skin trouble is secondary to the infiltration of the breast beneath, although in certain cases the glandular and cutaneous infiltration seem in point of time to coincide.

In the majority of these cases, however, the patient will describe a lump as having existed in the breast for some weeks, when suddenly the skin over it became red and mottled. If seen by the surgeon at this time, the redness may be that of inflammation, for which I have known it more than once mistaken, and with the redness there may be local increase of heat, a symptom which helps the error. The surgeon must not, however, be misled by these appearances and conditions, for he will, on passing his finger over the red and heated skin surface, at once make out that the skin has lost its softness and smoothness, and feels irregularly indurated; he will, moreover, not be able to raise the skin from the tumor, or, indeed, to separate it from the tissues beneath; the skin and tumor appearing as one. At times the surgeon will be surprised to see interspersed upon this red and heated surface irregular spaces of apparently healthy skin, a condition which by itself should be enough to suggest that the symptoms are not due to inflammation, since with inflammation no such spaces would exist. The fact, however, that to the touch this reddened skin is indurated and evidently infiltrated is sufficient evidence to decide the diagnosis in favor of acute cancerous infiltration. One of the most typical cases of this kind that I have seen was in a woman who was induced to put a hot fig poultice to a tumor in her breast, which had existed for some weeks. The poultice was applied and kept in position for a day, and on its removal I saw the woman. The skin of the breast was then, over an area exactly corresponding to that which had been covered by the hot fig poultice, red and apparently inflamed; to the finger it felt brawny. I suspected at the time that this condition was due to acute cancerous infiltration of the part, and the progress of the case proved the suspicion to be true; for the redness never subsided, and in one week the tuberculation of the skin was marked and characteristic. The case was clearly one of acute cancer, and I believe the local hot poultice hastened its growth.

The acute œdematous infiltration of the skin and breast is met with occasionally, and it is without doubt the most acute and fatal form of cancer found in the breast. It may attack the gland much in the same way as the acute tuberculated form which has just been described, but it may do so more insidiously, or rather less actively, and appears [illegible] as



April, 1871, with a breast which was œdematous and brawny, and with the skin over it full of flattened carcinomatous tubercles. The disease had appeared three months previously as a swelling of the gland, and great redness with œdema of the skin, over the gland. The redness soon subsided, but the swelling remained and became harder. The disease spread rapidly to the parts around, and the patient died in June, 1871, exhausted from probably internal disease.

CASE II.—Acute brawny carcinomatous infiltration of breast and skin; death in five months from discovery of disease.

Eliza B., aged 43, a healthy-looking single woman, came under my care December 13th, 1869, with acute disease of her right breast, existing only two months. The whole gland was infiltrated, and the skin over it like brawn. The nipple was depressed, and lost in the surrounding elevation of the breast; the axillary with the supraclavicular glands were enlarged. On February 17th the arm was œdematous. On March 3d the woman was sinking.

CASE III.—Acute brawny carcinomatous infiltration of breast and skin over it; death in six months.

Ann R., aged 53, a married woman, the mother of eleven children, the youngest being 12, came under my care on June 1st, 1857, with an acute brawny infiltration of her right breast and skin over it, and œdema of the right arm. She had been perfectly well up to three months before, when she noticed a swelling in her breast, which rapidly increased and became complicated with pain down the right arm, and swelling. When seen, the axillary and supraclavicular glands were much enlarged; the breast was like brawn, and the skin over it was evidently infiltrated with new elements, and œdematous. In one month all the symptoms were worse, and the skin became the seat of acute infiltration of cancerous tubercles. Cough also had appeared. On September 15th, that is within six months of the first appearance of her trouble, she died with internal cancer from exhaustion.

CASE IV.—Acute brawny cancer of both breasts, proving fatal in nine months.

Ann W., aged 49, the mother of six children, all of which she suckled, came under my care on January 26th, 1865, with an enormously swollen, œdematous, and indurated left breast,

of eight weeks' standing. There was pain in the part, which was worse at night, and there was at times increase of heat in the gland. The axillary glands were uninvolved, the integument over the breast was œdematous, and pitted on pressure. In the course of three months the axillary glands became enlarged. The œdematous integument over the breast became as hard as brawn, and ceased to pit; it often also became red as if inflamed. Three months later the arm became involved by extension of the brawny infiltration, and the right breast became similarly implicated, the disease in the right gland passing through all the same stages as it had done in the left; the right arm also became swollen. The patient lived nine months after the discovery of the tumor, and died from asthenia, with probably internal cancer.

CASE V.—Brawny carcinoma of breast; excision of gland; rapid death of patient from internal disease fourteen months after discovery of the tumor.

Eliza B., aged 32, a by no means unhealthy-looking single woman, came under my care on January 7th, 1870, with a tumor in her right breast of eleven months' standing. It had grown slowly up to a month ago, when it spread rapidly. At present the whole gland is generally infiltrated, although movable upon the pectoral muscle. The skin over it is like brawn; the nipple is retracted; the axillary glands are not to be felt. The tumor and skin over it were excised, and a good convalescence followed, but the woman died April, 1870, from internal cancer.

CASE VI.—Acute brawny carcinomatous infiltration, attacking breast damaged by suppuration; death in fifteen months.

Mary L., aged 36 (suckled five children, youngest nine months old), 3½ years ago had abscess in her left breast, but has been able to suckle with it since. January 7th, 1869. Three days after her last confinement, nine months ago, she had abscess in the breast, which opened in many ways; sinuses discharged for seven weeks, and then closed, after which a lump appeared in the breast, which has rapidly increased. At present the left gland is generally infiltrated, and the skin over it is like brawn, and full of tubercles; axillary glands enlarged; nipple drawn in. Six months later powers rapidly failing.

CASE VII.—Acute brawny carcinoma of breast in a pregnant woman, following abscess in the breast three years before.

A woman, seven months pregnant, aged 36, came under my care in February, 1886, with an acute brawny infiltration of her left breast and tuberculation of the skin over it. It had commenced as a lump seven months ago, with her pregnancy, and has steadily increased. The lump had appeared at the seat of an abscess she had three years before.

CASE VIII.—Acute brawny cancer of one breast, with lymphatic infection, and a local cancer in the other.

Harriet F., aged 28, a married woman, with one child four years old, which she had suckled with the left breast alone, came under my care in December, 1885, with an enlargement of her left breast, which had been coming for ten months, after a blow. The lump grew steadily, and was the seat of a sharp pain. Four months after its appearance the nipple began to retract. A month before she came to see me she poulticed the left breast; and after this the skin, which was white previously, became red. Two weeks previously she observed a lump in her right breast. When seen, the left breast was twice its natural size; the skin over it appeared to the eye red, and to be the seat of innumerable tubercles, varying in size from millet seeds to a threepenny-piece. The whole gland was hard, and the skin over it brawny and fixed to the parts beneath; the nipple was retracted. The lymphatic glands in the axilla and above the clavicle were enlarged. In the axillary lobe of the opposite breast there was a nodule of carcinoma the size of a walnut infiltrating one of the lobes. In the skin over the sternum there were likewise tubercles. No surgical relief could be suggested.

CASE IX.—Brawny cancer of both breasts; death in twenty months from onset of disease.

Mrs. A. D., aged 41, the mother of five children born dead, consulted me on November 7th, 1869, with both breasts generally infiltrated with cancerous disease, and the skin over them brawny and tuberculated; both glands were fixed to the chest, and the axillary glands were enlarged. The disease of the right gland had been coming for fifteen, and that of the left for seven months. The left breast was ulcerating, this process having commenced in the nipple. The woman looked well; within six months she died with lung trouble.

CASE X.—Acute cancer of breast, with lymphatic infiltration of skin; excision; convalescence.

Fanny A., aged 35, came under my care on October 27th, 1883, with a tumor in her left breast. She had had one child eleven years ago, and suckled, though with sore nipples. Three months before admission she discovered a lump in the centre of her left breast, the size of a bantam's egg; this had steadily increased. When seen, the whole breast seemed to be generally enlarged; the nipple was retracted; and the skin over the tumor showed white lines radiating from the nipple; these lines, which felt by the finger like hard cords, were clearly lymphatics. The skin was slightly œdematous; no axillary glands felt. On November 5th the breast was removed and the axilla explored, some glands being found. The patient did well. The tumor was clearly carcinomatous, but of the softer kind. The skin was evidently infiltrated, and the lymphatics in it choked with cell elements. The external view of this condition is well seen in Plate IV., Fig. 1. I am unable to trace the subsequent course of this case.

CASE XI.—Acute brawny carcinoma in a woman, aged 71, following a blow.

Charlotte M., aged 71, came under my care, July, 1884, with an acute carcinomatous infiltration of her right breast, with lymphatic infection of the breast and tuberculation of the skin over the tumor. All these symptoms had appeared within one month, and had followed the appearance of a lump in the breast, which had made its appearance five months after a severe blow upon the part.

CASE XII.—Brawny carcinoma of left breast in a woman aged 75.

Laura D., a widow, aged 75, came under my care in December, 1872, with a hard, tuberous, carcinomatous growth in her left breast, which had commenced six months previously as a small lump the size of a plum, and had steadily increased. When seen, the tumor was the size of a fist, and occupied the whole gland. It was very hard, and felt as if made up of several distinct tumors. The skin over the tumors was œdematous, and felt like brawn. The nipple was retracted and the axillary glands were enlarged.

CASE XIII.—Carcinoma in an ill-developed breast, which had been damaged by an abscess; lymphatics infiltrated, and skin tuberculated; operation; death within a year.

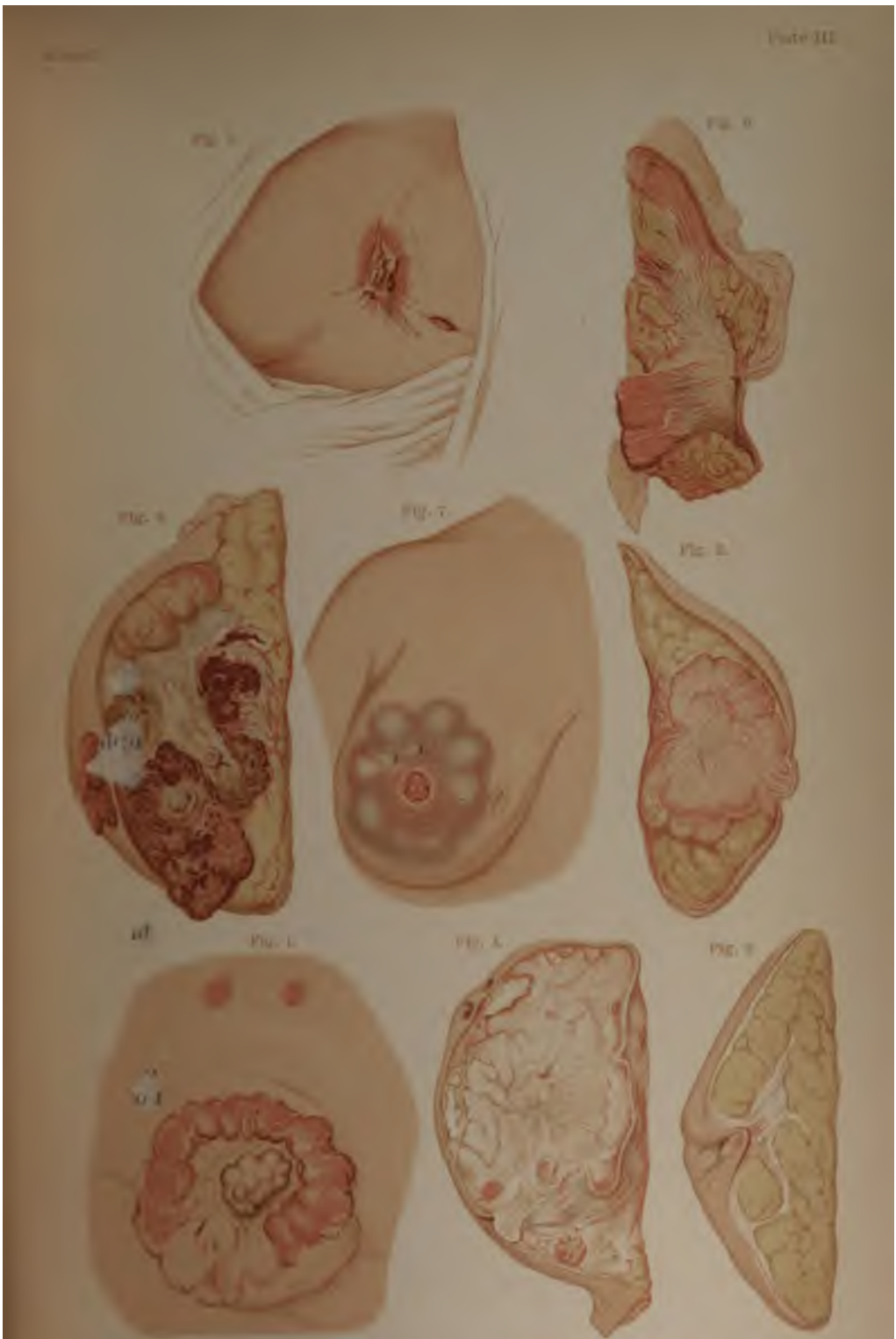
Eliza B., aged 62, the mother of three children, all of whom she suckled with the right, but not with the left breast, as it was not fully developed. During the second lactation an abscess appeared in the left breast. One year before she consulted me, on November 23d, 1879, she noticed a small lump in the left breast. This increased slowly up to four months ago, when it became painful. When seen, the whole left breast was infiltrated with some neoplasm; the skin over it was adherent; and radiating from the nipple, the lymphatics in the skin appeared as hard, white, radiating lines. There were also in the skin many pink tubercles. The nipple was retracted; the breast itself was nodular and hard; the axillary glands were apparently unenlarged. November 28th: Breast removed and axilla explored, some enlarged glands being removed. The patient did well. Temperature after operation never ran above 100°. A section of the growth showed a perfect specimen of carcinoma of the softer variety, which had involved the skin generally. The white radiating lines were clearly lymphatics infiltrated with cancer elements. The patient did well after the operation, but died within twelve months from a return of the local disease and chest complications.

CASE XIV.—Acute tubercular carcinoma affecting breast, with depressed nipple; death in fourteen months.

Ann G., aged 46, the mother of twelve children, the youngest being one year old (she never suckled with her right breast, as the nipple was retracted), came under my care January 2d, 1868, with acute carcinomatous infiltration of her right breast, with nodular skin tubercles over the gland, and enlargement of the axillary glands. The disease had commenced ten months previously. On May 8th, fourteen months after the discovery of the tumor, she sank.

CASE XV.—Acute tubercular carcinoma of both breasts and integument of the chest and abdomen; ulceration of left breast.

Harriet L., aged 45, a married, childless woman, came under my care in July, 1879, with a cancerous infiltration of both breasts, also of skin over the breasts, and covering the sternum, chest, and abdomen. The skin looked red, and felt hard, nodular, and fixed to the parts beneath. Both nipples were retracted, and the axillary glands on both sides enlarged. The



CARCINOMA OF THE BREAST.

1. Paget's Disease of the Nipple.
2. Section of Carcinoma.
3. Sarcomatous Scirrhus.
4. Section of soft Carcinoma.
5. Carcinomatous Ulcer.
6. Section of same.
7. Colloid Carcinoma.
8. Section of same.

disease had commenced two and a half years previously as a small hard lump behind the nipple of the left breast, which had appeared two months after a blow upon the part. Two months later the nipple retracted, and the tumor spread. Eight months ago the skin became discolored and lost its softness, and about this time a lump was noticed on the opposite breast. Three months ago the skin over the left breast ulcerated, and there has since been discharge. Four months ago she had pain in both axillæ, and two months later œdema of the left arm. Her general health was good, and she had no ill aspect. Nothing could be done.

Ulceration of a Cancerous Tumor.—In an early page of this work it was pointed out that cancerous tumors, like other neoplasms, are shorter lived than the normal tissues in which they are placed, and that they will to a certainty, in the course of their progress, undergo degenerative changes, if not death. Under such circumstances any carcinomatous tumor, or, indeed, any tumor of the breast, cancerous or otherwise, will sooner or later break down either in its centre or on its surface, and give rise in the latter case to a cancerous ulcer (Fig. 5), or in the former case, to a cancerous cavity, which discharges from its centre after the manner of an abscess (Plate II., Fig. 6).

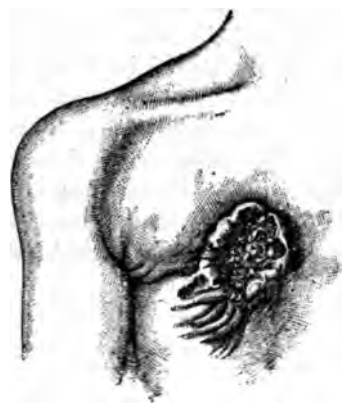


Fig. 5.—Carcinomatous Ulcer of Breast.

The cancerous ulcer will present features which will correspond to the form of cancerous tumor from which it originates. Should it follow the degeneration of the atrophying scirrhous variety described in class 1, the ulcer will be of the most indolent kind, and appear simply as a surface deprived of its upper layer of epithelial elements, and discharging hardly more than the crumbling débris of a withering tumor. This variety of ulcer may, indeed, dry up, but it can hardly be described as healing (Plate III., Figs. 5 and 6).

Should it be consecutive to the breaking down of the more

common variety of carcinoma fibrosum (class 2), the ulcer will be typical of what is known as a cancerous ulcer (Fig. 5); that is, it will present an irregular surface, discharging serous fluid containing the débris of degenerating and breaking down epithelial tissue, with raised, thickened, infiltrated, and everted edges, which are so unlike the edges of any ulcer the result of inflammation, as to forbid an error in diagnosis being made. The process of degeneration which originated the cancerous ulcer steadily continues, and consequently the ulcerating process spreads; for a cancerous ulcer rarely heals; it is almost always a spreading one, and continues until the patient is exhausted. Cancerous ulcers do not fungate; fungating growths are usually sarcomatous.

When the degenerating or dying process commences in the centre of a cancerous growth (as it does when the disease is more of the tuberous than of the infiltrating variety of cancer, as described in class 3), the ulcerating skin process will be consecutive to the formation of what clinically might have simulated an abscess; since it would have commenced as a softening process of the centre of the dead and dying neoplasm, and continued as an extension of the process through all the parts which covered in the cavity, till the tissues outside gave way and permitted the escape of the cavity's contents.

The material that escapes from the cavity would be dead tissue mixed with the fluids of the dying parts; the walls of the cavity would be degenerating cancer; the edges of the opening through which the dead tissue escaped would likewise be cancerous, for they would appear as thick, raised, elevated, infiltrated, pouting, everted lips, from between which a thin, ichorous, and probably fœtid discharge would escape, the discharge consisting of the débris of dead and dying tissue.

When the skin is tuberculated in any of the ways previously described, there may be ulceration, the tubercles to a certainty eventually undergoing degenerative changes and breaking down. Under these circumstances there may be many ulcers, but each will have its own special character, which will correspond to one or other of those which have been described. In the brawny form of cancerous infiltration the ulceration may be extensive, the breaking-down process generally commencing in the skin tubercles and spreading to the deeper parts. This process is rapidly exhausting, and soon terminates life.

In exceptional cases the whole or part of a tumor may die outright, and then slough off. This result happens at times when the tumor becomes the seat of an inflammation, and particularly of erysipelas.

By way of summary, I quote a paragraph from Gross's excellent work on mammary tumors, not that I can indorse from an analysis of my own cases his carefully worked-out and definite averages, for my own cases do not give me with sufficient accuracy the necessary data, but because upon the whole I believe his deductions to be practically valuable:

"From the preceding facts we learn that carcinoma evinces a remarkable disposition to infect the adjacent tissues, and that it progresses at first toward the surface. The skin is invaded in 68.9 per cent, deep attachments ensue in 21.9 per cent, and the opposite breast suffers in 3.6 per cent of all instances. The occurrence of local dissemination is, moreover, indicated by the formation of circumscribed nodules in the skin in 10.6 per cent; in the subcutaneous connective tissue in 8.39 per cent; in both these situations, as in the cuirass form of cancer, in 1.95 per cent; in the pectoral muscles in 7 per cent; in the intercostal muscles in 1.35 per cent; and, finally, in the ribs in 2.8 per cent.

"In the order of the date of these appearances, we may look for extension to the superficial fasciæ and skin in 14 months, for ulceration in 20 months, for fixation to the chest in 22 months, and for invasion of the second breast in 32 months."

Clinical Features of a Medullary (tuberculous) Carcinoma (Plate II., Fig. 4; Plate II., Fig. 6; Plate III., Fig. 4).—In this form of carcinoma the cell element predominates largely over the fibrous, and there is no tendency to such contraction of the growth as is well known takes place in the scirrhous variety. The tumor consequently grows more rapidly, assumes a more lobulated outline, is softer to the touch, as well as more elastic and semi-fluctuating than scirrhus. In it also the nipple is flattened out, not retracted. The tumor may grow to a great size in a few months. The last example I saw was the size of a cocoanut. As the tumor grows the skin becomes stretched, and full blue veins become very conspicuous on its surface; later on the skin becomes adherent to the tumor by infiltration; it may even assume a red and inflamed

appearance, the redness being really due to acute infiltration. To the finger the skin will feel, as previously described, œdematous or brawny. At a still later stage ulceration will occur.

Before this stage has been reached, indeed probably before the skin has become fixed to the neoplasm, the axillary or clavicular glands will have enlarged; when this lymphatic infection has taken place the disease goes on rapidly. This soft form of carcinoma, like the scirrhus, is an infiltrating affection; it is rarely if ever encapsuled; it differs from the scirrhus form more in its mode of growth than anything else. At times the cell growth increases so rapidly that it forms a mass, which, being imbedded in the mammary gland, has a circumscribed appearance, suggestive of being encapsuled. In other cases the disease may develop within a cyst, and so really be encysted. In such cases the presence of other cysts will explain its appearance. It has, however, doubtless often been mixed up with sarcoma, and I am convinced that I, in common with others, have fallen into this error. Cases which have passed under my care during the last ten years or more, which I should formerly have described as examples of medullary carcinoma, I have called adeno-sarcomata; and I may say that I have not seen for many years, until quite recently, a good example of this affection. On looking into the literature of the subject, the above conclusion became very evident, and cases have been described of this affection which would have been better called acute carcinoma or rapidly growing sarcoma. For in carcinomatous, as in sarcomatous, tumors, there is great variety, and this variety is determined in both classes by the relative proportion of the fibrous and cell elements. When the fibrous element predominates, a scirrhous tumor is said to exist if the neoplasm be of the carcinomatous type; whereas if the cell element predominates, it will approach the character of what has been described as medullary carcinoma.

Under these circumstances it would probably be wise if the term encephaloid variety of carcinoma was abolished, for clinical experience tells us that in the long chain of varieties which forms the carcinomatous group of tumors, there may be innumerable degrees as to density and cell growth.

Clinical Features of a Colloid Carcinoma.—This is probably always a degenerative change of a carcinomatous tumor,

although in exceptional cases the colloid change is such an early feature of the disease as to suggest that it may be a primary growth.

It is found mostly in women after 40, as is carcinoma, but it may be met with in younger as well as in older subjects. It is rarely an acute affection; indeed, it seems to be of slower growth than the majority of cases of scirrhus. It begins as a lumpy swelling in a lobe of the breast, not as a simple induration as in scirrhus, which steadily increases. At first its growth may be slow; later on it becomes rapid. The outline of the tumor is usually bossy. The disease is generally preceded by nipple discharge, and this discharge is usually sanious (Plate III., Figs. 7 and 8).

There is at times retraction of the nipple, but this symptom is not constant. To the finger it feels firm but elastic, and the bosses upon the tumor are suggestive of cysts. The discharge from the nipple supports this view. In the course of its progress the skin will become adherent, and later on ulcerated; through the ulcerated openings the gelatinous or colloid fluid will ooze. The edges of the ulcerated opening are not infiltrated as in carcinoma, but more resemble the sharply-cut edges of the cystic sarcomatous growth.

Cases have been recorded of colloid carcinoma in which the skin has become tuberculated and the tumor fixed to the pectoral muscle. I have not seen those symptoms associated with it.

In the fifth volume of the Pathological Society's Transactions, a case of the late Sir W. Fergusson is recorded, in which recurrence after removal took place on at least two occasions. The patient was originally under Mr. B. Travers's care in 1845, when the breast was removed. Three years later a tumor was taken away from the cicatrix; and five years later again Sir W. Fergusson excised several tubercles from the same part. The disease had therefore existed for eight years, and then seemed to be local. The patient was at last operation aged 38.

The disease may spread by lymphatic infection, though this rarely takes place till a late period of the case; indeed, the disease may have existed for some three, six, or more years before this symptom appears. In a case of my own the disease had existed for seven years, and it was then quite local.

In brief, colloid carcinoma is a slow-growing tumor, and the least malignant variety of carcinoma; it approaches, in fact, more the benign than the malignant growth. It is, however, difficult to diagnose before the degenerating or ulcerating stage has been reached, when the discharge of the glutinous, colored, white-of-egg-like material from the ruptured cavity, and the well-defined uninfiltrated edge of the open wound clearly reveal its true nature. In its early state it never has the hardness of a scirrhous carcinoma, nor the roundness of an ordinary sarcoma, as seen by the drawing (Plate III., Fig. 7); it has a bossy outline, more like an adeno-sarcoma or cystic sarcoma than anything else, and for the latter it is the most likely to be mistaken. I have seen but two examples of this affection, the one I now give an abstract of, and a second very similar to it in a woman, aged 56, who refused operation, and of whose future history I cannot learn anything.

Case I.—Colloid disease of the breast of seven years' growth; removal of gland; seven years later carcinoma of the nipple of the opposite breast, following a local eczema; no return of colloid disease.

Charlotte J., aged 65, a healthy, married, childless woman, came under my care on April 2d, 1873, with a tumor in her right breast. The disease was first observed seven years before as two small lumps close to the nipple; a year later these lumps, which had not increased much in size, had changed color. Since then the tumor has slowly and painlessly increased. Six months ago, when the tumor began to grow rapidly, pain appeared; and three months later the tumor burst and discharged a thick blood-stained fluid, which has continued ever since. On admission the tumor has a livid appearance, and measures six inches in diameter (Plate III., Fig. 7). It is clearly lobulated, and each lobule fluctuates. The opening into one of the lobules is clean cut, and from it flows a thick glairy jelly-like colored fluid. On April 8th the tumor was excised, and a good recovery followed.

On making a section of the growth its lobular nature was very marked. Each lobule was made up of a colored jelly-like material, this caseating in parts. Under the microscope, in the fresh state, it showed a delicate stroma of connective tis-

sue forming loculi, in which large granulation-like cells were found (Plate III., Fig. 8). The patient remained well for more than seven years, when so-called eczema attacked the nipple with its areola of the opposite breast, and as this did not heal after six months' treatment she came to me. I then found, May 4th, 1881, a typical example of Paget's disease of the nipple, the base of which was indurated, and the nipple retracted. The lymphatic glands were not enlarged. The cicatrix of the operation upon the opposite breast was quite healthy. The woman at this time was 73, so no operation was suggested.

I am able to report that this woman was alive and in good health in 1886; that the local carcinoma had but slightly increased; and that there was no return of her colloid disease.

In this case, therefore, a colloid carcinoma, which had existed for seven years before it was removed, showed no signs of return thirteen years later. It will be interesting to observe whether the carcinoma of her left breast, from which she is now suffering, will undergo a colloid transformation.

CHAPTER XIV.

TREATMENT OF CARCINOMA OF THE BREAST.

If the view of carcinoma taken in the previous pages be correct, and the disease is to be regarded primarily as a local one, there can be no question as to the principle of practice which should be followed in its treatment, and that that principle can be summed up in the one word, removal; meaning by that word the entire removal and complete extirpation of the local affection. This practice is based upon the conviction that if the smallest particle of diseased tissue be left behind, what remains will continue to grow; and that the partial removal of a carcinomatous growth tends to induce injurious changes in, as well as a more rapid growth of, what is left, whether that remnant be left in the seat of the original growth, or in the lymphatics which pass from it.

Charles Moore, of the Middlesex Hospital, saw this so long ago as 1867, and in a valuable paper, "On the Influence of Inadequate Operations upon the Theory of Cancer,"[32] laid it down as a law that "the one important point, both for practice and theory, is to remove the whole. The least remnant is capable of growth, and may spring up into a new tumor with all the energy of the first." "When any texture adjoining the breast is involved in or even approached by the disease, that texture should be removed with the breast. This observation relates especially to the skin, to lymphatics, to much fat, and to the pectoral muscle. The attempt to save skin which is in any degree unsound is of all errors, perhaps, the most pernicious, and whenever its condition is doubtful that texture should be taken away. A broad scar, and the stretching and compression due to its subsequent contraction, appear to be especially satisfactory. In the performance of the operation it is desirable to avoid, not only cutting into the tumor, but also seeing it. No actual morbid texture should be exposed, lest the active microscopic elements in it be set

free and lodge in the wound. Diseased axillary glands should be taken away by the same dissection as the breast itself, without dividing the intervening lymphatics, and the practice of first roughly excising the central mass of the breast, and afterward removing successive portions which may be of doubtful soundness, should be abandoned." These remarks of Mr. Moore's had reference rather to the practice of the day, in which the tumors were removed from the breast, and the nipple with portions of the gland left, rather, than to the general exploration of the axilla for enlarged glands as recently advocated.

Thiersch also laid down the maxim that all operations upon epithelial cancers should be conducted solely with reference to their thorough eradication; that all epithelial cancers should be operated upon if they can be effectually; that a partial operation is, as a rule, a surgical blunder. In more recent times this principle of complete removal of the local disease has been considerably extended, and we find Mr. M. Banks, of Liverpool,[33] Mr. Pearce Gould, of London,[34] with Küster, of Berlin, and others, advocating in no feeble way the routine practice of exploring the axilla of every patient from whom a cancerous breast is to be excised. Küster in support of the practice asserting that at least one-third of his cases treated in this way have remained well for three years, the period which leads Gross to regard as equivalent to a cure.

With the leading thought of complete removal, therefore, engraved on the surgeon's mind, the corollary is clear that the earlier the local disease is taken away the more favorable the result is likely to be; for theoretically it can hardly be doubted that if, on the very first onset of the trouble, the disease could be extirpated, a large number of cures would have to be recorded. If an epithelioma of the skin can be cured by an early removal, surely it is a reasonable hope that a carcinoma (epithelioma) of the breast will likewise be curable if treated in the same way, that is, by an early excision.

Early operation, as well as complete removal, are consequently the two essential points to observe in the treatment of this serious malady, if operative interference is undertaken under any idea of bringing about a cure.

On Early Removal.—When a carcinoma of the breast has so grown as to present features which make the diagnosis

of the disease certain, the trouble has far advanced; it has probably reached the stage already described as that of mature infiltration; for infiltration of the gland of a typical character, with dimpling or puckering of the skin over the gland, and possibly some retraction or dragging of the nipple, are advanced symptoms of breast cancer, and indicate to a certainty that the infiltration of the lobe of the affected gland, which was primarily local, has spread beyond its original sphere so as to affect the coverings of the gland, and more of the gland than the single lobe in which it originated.

A breast thus affected should doubtless, as a rule, be at once wholly removed; but it cannot be denied that the removal of the gland under these circumstances is less likely to be followed by a complete cure, that is, a permanent absence of the disease, than might reasonably be looked for if the breast had been taken away before these well-marked symptoms had put in an appearance.

The removal of the diseased gland under the circumstances described, is, however, far more likely to be followed by a good result, than could be anticipated if lymphatic infection complicated the case, such infection being unquestionable evidence of secondary cancerous extension.

What local symptoms, it may therefore be asked, should be considered of sufficient weight to lead the surgeon to suspect a local cancer; and under what circumstances may this suspicion of a local cancer justify the surgeon in recommending surgical interference?

A satisfactory answer to these questions will be found in the chapter devoted to the consideration of the clinical features of a scirrhous carcinoma (Chapter XIII.); but it may confidently be asserted that it is by the removal of the disease in its early infiltrating state that the best hopes of the surgeon may reasonably rest.

It is not, however, to be supposed that such an operation as excision of the breast gland is to be recommended or carried out, when possibly the clinical symptoms are no more than a local infiltration of a single lobe, and that infiltration has not been proved to be cancerous, for such advice would be wrong; but I would strongly urge upon all surgeons the propriety of making an exploratory incision into any tumor of the breast which seems to be infiltrating, and which may

probably prove a carcinoma, in order that the complete extirpation of the diseased breast may follow, should the incision into the diseased part clear up the doubts which hung about the case, and make the diagnosis of carcinoma certain; while, on the other hand, if the tumor of the breast, into which an incision has been made, turn out to be of a simple character, the means adopted for diagnostic purposes may probably suffice for its enucleation or cure.

The diagnosis of early tumor is uncertain, writes Marcus Beck (Heath's Surgery), and yet if the disease is malignant, the only hope of cure lies in early recognition of its nature. In these cases, therefore, an exploratory incision should always be made. If the tumor is one of the simple growths, its smooth surface will be seen as soon as the capsule is opened, and the mass can be turned out without difficulty. If it is a sarcoma, its soft structure and less perfect outline will be recognized. If it is a cyst or an abscess, the contents escape; and if it is an indurated lobule, its leathery toughness, and perhaps the small retention cysts, will be recognized. If it is a scirrhus the "creaking of the knife as it enters it, and the sensation like cutting an unripe pear, and its sharp hard edge, not separable from the surrounding tissues, clearly show its nature."

"If the case is a very doubtful one, a freezing microtome and a microscope should be at hand, and a section should be mounted from a small slice taken from the growth. In this way all doubts are set at rest. 'Waiting till symptoms develop,' in the case of cancer, means waiting till all hope of cure is gone."

All chronic indurations of the breast in women over forty years of age, not enfeebled from age or infirmity, in which there is absence of evidence of its being inflammatory, should consequently be explored by an incision with the view of the exploratory measure being followed by excision of the breast, should the induration prove to be a carcinomatous infiltration.

Exploratory operations under these circumstances I hold to be of great practical and scientific value, and it would be well if they were always made. It would be far better for a surgeon to make at times an exploratory incision into a breast tumor under an erroneous impression, than to allow a carcinoma in the stage of early infiltration to advance and involve other structures, when we know that it is at this stage of early

infiltration that its complete extirpation is most likely to prove permanently successful.

When enlargement of the lymphatic glands complicates the case of carcinoma of the breast, the disease may still be taken away if the surgeon sees a reasonable possibility of the removal of the affected glands with the primary growth, and the general condition of the patient justifies the attempt. To take away the breast gland and leave the affected lymphatic glands is but a partial measure, since the disease by the operation is only partially removed, and the lymphatic glands which are left behind are likely, after the removal of the breast, to increase rapidly, and become fresh centres from which new troubles may emanate

When, therefore, it is expedient to take away any well-marked carcinoma of the breast, it is a wise practice, in the majority of cases, to lay open the axilla at the same time, and look for enlarged lymphatic glands; since it is now the common experience of surgeons to detect them after an incision, where before none were suspected. I have adopted this practice very generally for about ten years, and have reason to be fairly satisfied with the results. But I have not done so as a blind routine. In thin women in whom an axilla can be well explored digitally, I have not made this incision; nor have I, in certain other cases, particularly in feeble women or in those advanced in life, in whom I felt the extra measure, by its increased severity, might prove detrimental, and more particularly when the axillary manipulation has been efficiently made with the patient under the influence of an anæsthetic, and no enlarged glands were to be felt. The rule of practice ought, however, to be axillary exploration in the majority of cases of excision of the mamma for cancer; the omission of the practice the exception.

When a carcinomatous breast has broken down and is ulcerating, it may be removed if not too firmly fixed to the deeper structures, the disintegrating change in the tumor affording, indeed, an extra argument in favor of operation; and should the primary growth be associated with lymphatic glandular enlargement, and there is no reason why these infiltrated glands should not be taken away on account of their great fixedness or the age or general enfeebled condition of the patient, the surgeon should take them away with the pri-

mary growth, and so work for a cure. But should this complete operation be contra-indicated on account of the size of the tumor relatively to the age or infirmity of the patient (the removal of the breast with the lymphatic glands being, without doubt, a graver measure than the removal of the breast alone), the incomplete operation of the removal of the breast alone may be carried out; this partial measure being undertaken solely as one of expediency, and with the view of removing a local source of distress and weakness, and of making what remains of life more comfortable.

Should the tumor be firmly fixed to the pectoral muscle or deeper parts, and the glands in the axilla be found immovable, or those above the clavicle enlarged, the surgeon had better leave the case alone.

Should the tumor also be very large, and the shock of its removal likely to be severe when the age of the patient or her feebleness is taken into account, non-interference should be the rule of practice; whereas should the tumor be small and movable, and the woman yet old, it may be right and expedient to take it away. An operative measure, which in the middle-aged or comparatively healthy woman would be justifiable, may clearly be the reverse in the aged or enfeebled; and a small tumor may often be taken from a healthy old patient, when a large one in an enfeebled middle-aged woman had better be left alone.

Certain old women, particularly the thin and wiry, bear operations very well, and such may frequently be submitted to surgical treatment which their fatter or feebler sisters would be unable to support.

When carcinoma of the breast is associated with pregnancy, the treatment of the case is, indeed, difficult. To let the disease of the mamma go on with the physiological process of pregnancy, even up to if not through lactation, is to give the disease the best chance of making rapid progress, and to advance beyond surgical interference, and yet to operate during pregnancy is a measure of danger.

The certainty of the evil of delay is, however, greater than the certainty of the evil of action, and I am disposed to think that upon the whole the advantages of action are the greater, and the practice based upon it should be advocated. In the three following cases in which this practice was followed the success was sufficient to justify the means.

This practice is, however, to be followed with extreme caution, and after the fullest consideration of the facts of the individual case.

CASE I.—Carcinoma of breast and pregnancy of seven months; excision during pregnancy; natural labor; no return two years later.

Mrs. S., aged 46, the mother of many children, came to me on May 14th, 1879, when she was pregnant seven months, on account of an acute carcinoma of her right breast, which came on with and developed during pregnancy. I excised the breast and the patient did well. She was confined on July 4th; and had a natural labor. There was no return of her disease two years later.

CASE II.—Carcinoma mammæ; pregnant seven months; operation during pregnancy; recovery; survived operation two years.

Mrs. S., aged 42, the mother of four children, the youngest being one and a half years, who had not nursed with her right breast from defect of the nipple, came to me on May 10th, 1879, when pregnant seven months, with her right breast infiltrated and nipple ulcerated; no enlargement of axillary glands. The breast was removed and a good recovery followed; she was confined at the full period naturally, and had no breast trouble. She died December 31st, 1881, or two and a half years after the operation, from internal cancer.

CASE III.—Carcinoma mammæ; pregnant six months; operation during pregnancy; convalescence; confined at full time; survived operation one year.

Mrs. B., aged 48, the mother of eight children, the youngest being seven years of age; the first two of which she suckled without trouble, and with the later children used her right breast more than the left, consulted me on February 28th, 1876, when six months pregnant, with an infiltrating tumor in her right breast of six months' standing. The whole gland was involved. I excised the breast, and a good recovery followed. She was confined at the full period and the labor was natural. She survived the operation one year.

When the question of operative interference is raised in cases of carcinoma of the breast, the nature of the carcinoma,

the size of the tumor, and the clinical history of every case should be considered. A measure which would, under one set of circumstances, be right, would under another be wrong; and an operation which, in one variety of the disease, would be expedient, in another would be quite the reverse. I propose, therefore, now to consider the question of operation in the different forms of carcinoma to which attention has been drawn.

Operations in the atrophic or withering variety of carcinoma are not to be advocated. Such cases are very slow in their progress, and although slow they are, as a rule, sure. Women with this variety of carcinoma almost always die eventually from internal disease; and it seems that interference with the local disease often helps to cause the rapid growth and increase of secondary deposits, which at the time were not manifest. It is probably true that if the disease were removed at its first stage, that of early infiltration, good results might be obtained, in the same way as it is hoped that by early operation in the ordinary carcinoma fibrosum, like good results would have to be recorded. But, as a rule, patients suffering from this atrophic variety of carcinoma do not seek advice till the disease has existed for years, when in all probability it has ceased to be a local affection, but has become disseminated in some way, and probably by means of tubercles. Under these circumstances, local interference, or the partial removal of the disease, is followed by what may generally be looked for, the rapid development, or rather growth, of whatever secondary deposits may exist, either as lymphatic enlargements, or secondary metastatic, or disseminated tumors.

These are, moreover, the case of carcinoma which live the longest. They are those that, when mixed in statistics, tend to raise the average duration of life to a higher level, and that induce surgeons to believe that non-interference in carcinoma of the breast generally gives a longer life. (See cases reported, page 151.)

Operative interference in the acute or brawny variety of carcinoma is not to be advised. When I have been tempted to remove a breast under these circumstances, I have rarely had any satisfactory result; a speedy return, or rather rapid growth of the disease having been the rule, and a long im-

munity quite an exception. The truth is, in this variety of cancer it is impossible for a surgeon to know the limit of the local affection, if, indeed, it be local; and under these circumstances, when an operation is made, it must be regarded as only a partial or incomplete measure. The brief reports of cases of this variety of carcinoma printed at page 187, will show how acute this trouble is, how rapidly it becomes diffused, and how futile operative interference is likely to be.

***Treatment of Carcinoma of both Breasts.*—There is no reason why both breasts, when simultaneously affected with carcinoma, should not be taken away, if by doing so the disease can be wholly removed; and there is no reason why the second breast, when so affected, should not be amputated when it has become the seat of carcinoma after the lapse of weeks, months, or years following the removal of its fellow for a like trouble.**

The only bar to a double operation at the same time, or with an interval of time, is either the presence of lymphatic, glandular, or secondary deposits, which cannot be taken away; or a feeble general condition of the patient which would be unable to stand the depressing influence of a large operation.

I append some cases of this comparatively rare condition. In several, both breasts were removed at different periods; in others, one only was operated upon, a second operation, for various reasons, not having been performed; in a third class no operation was undertaken.

CASE I.—Carcinoma of both breasts; operations; recovery; the left was affected two and a half years after the right had been removed.

Harriet W., aged 60, came under my care in March, 1884, with a typical carcinoma fibrosum of her right breast, which had been coming on as a tumor for eight months, although the breast for a year previously had been the seat of pain. There were no enlarged lymphatic glands. Two and a half years before she had had her left breast removed for cancer, which had been growing for several years. When removed, it was an open ulcer. The axilla at the time of operation was not explored. On March 25th the breast was alone removed, and a good recovery followed. This woman was alive eighteen months later.

CASE II.—Carcinoma of both breasts; operations at fifteen months' interval; death in five years.

Catherine T., aged 50, a widow, came to me on October 22d, 1866, with an infiltrating cancer of her left breast, a retracted nipple and dimpling of skin. It had been coming on six months. In December, 1865, I had removed her right breast for infiltrating cancer, and a good recovery ensued. The axilla was not explored. In March, 1867, the left breast was removed, and a good recovery ensued; no axillary glands were felt enlarged. November, 1867, tubercles appeared in the skin over the thorax. March, 1869, cicatrix of right side sound, of left contains tubercles; left axillary glands likewise enlarged. This patient died in 1870 from internal cancer.

CASE III.—Carcinoma of both breasts; operations.

Miss V., aged 34, consulted me in November, 1877, for carcinoma of the left breast of two months' standing. I excised the gland, leaving the axilla unexplored, and convalescence followed. She left, a few months later, for America, where, one year later, the disease returned in the right breast, which was likewise removed. She lived about two years after the second operation, and died from chest complication.

CASE IV.—Carcinoma of both breasts; one breast removed; survived operation three and a half years.

Miss B., aged 55, who had always had a retracted nipple in her left breast, consulted me in October, 1868, for a tumor which had been discovered one week, and was attended with pain which had existed for six months previously. When seen, the left breast was generally infiltrated, although the skin over the tumor and the lymphatic axillary glands were uninvolved. Breast removed; axilla not explored; good convalescence. October, 1869, tubercle in scar. February, 1870, tubercles multiplying; right breast infiltrated very slightly. Died March, 1872, three and a half years after operation. This patient's maternal aunt had died from cancer of the breast, and her maternal uncle from cancer of the throat.

CASE V.—Carcinoma of breast of six months' standing; removal of breast; well for three years and a quarter, when return took place in scar and opposite breast.

Bridget W., aged 35, a married childless woman, applied to me on December 21st, 1865, with an open cancerous ulcer occupying the seat of the right breast, which had been re-

moved four years before for carcinomatous tumor of six months' growth. The patient had remained well up to nine months before. When seen, the left breast was likewise infiltrated with cancer, and the skin over the chest was covered with tubercles. Four months later the patient was sinking.

CASE VI.—Double carcinoma mammæ; removal of one breast; return of disease in the opposite; removal of gland; death from chest disease 2½ years after first operation.

Miss C., aged 45, consulted me in 1874 with an infiltrating carcinoma of her right breast which she had discovered one year. The axillary lymphatic glands were not enlarged. On January 13th, 1875, I excised the breast, but did not explore the axilla. A year later the opposite breast became diseased, and was removed, and within six months tubercles rapidly developed over her chest, and she died from chest cancer on July 7th, 1877.

CASE VII.—Carcinoma mammæ (double); one removed; second breast involved two years later.

Mrs. S., aged 46, the mother of one child, which she suckled, came to me with cancer of her left breast of six months' standing, and infiltration of the skin over the breast and of the axillary lymphatic glands. Two and a half years previously she had had her right breast excised for cancer of six months' growth. No operation was advisable. Subsequent history of case unknown; but she could not have survived many months. This patient's parents were alive, and one was 70 years of age. Her paternal grandmother had cancer of the womb. One paternal uncle had cancer of the stomach, and a second cancer of the liver.

CASE VIII.—Cancer of both breasts; one successfully treated by injections of acetic acid.

Mary W., aged 62, the mother of ten children, all of whom she suckled, although with one twenty years before she had had an abscess in her right breast. She came to me on April 19th, 1866, with her right breast enlarged from carcinomatous infiltration, the skin over it adherent; the nipple retracted, and the axillary glands enlarged. There had been a lump below the nipple for five years. I injected acetic acid into the growth in many places, and on many occasions, and the operation was followed by sloughing of the whole mass, with the skin over it. The wound subsequently healed, and a good

scar formed. On November 29th she came to me with the opposite breast the seat of a central tumor. After this her powers soon began to fail.

CASE IX.—Carcinoma of both breasts (chronic); lived six years; no operation.

Eliza C., aged 72, a single woman, came under my care on February 6th, 1865, with a chronic carcinoma of her right breast of five years' standing. The whole gland was infiltrated and hard. The tumor was fixed to the chest, and the skin over it was puckered and covered with tubercles. The nipple was retracted and also infiltrated; the axillary glands were enlarged. With tonics the patient's health improved, and the enlarged axillary glands disappeared. June, 1865, the left breast became involved, the first symptom being some general thickening; by November the infiltration of the gland was very general, but the nipple remained natural. In November the right breast began to ulcerate. January, 1866, cough appeared. April, 1866, the right arm became œdematous, the left breast was enlarged, and shot-like tubercles appeared in the skin over the breast. A few months later the patient died with chest trouble. The disease on the whole had lasted six years.

CASE X.—Cancer of both breasts of three years' standing; no operation.

Mary S., aged 58, the mother of one child, aged 24, who, when suckling, so bit the left nipple that it ulcerated off, came under my care on July 26th, 1869, with cancerous infiltration of both breasts. Skin over them adherent and puckered, and axillary glands likewise swollen. The disease began three years before I saw her in both breasts at once.

The patient sank in the course of a few months.

Treatment of Recurrent Growths.—In the treatment of these a surgeon's judgment should be guided by the same principles of practice which influenced his decision in the case of the primary operation; that is, if the recurrent growth stands alone, and can be removed, the operation is justifiable. It may be that the growth, which appeared to be recurrent, was but the continued growth of some of the elements of the tumor which had not been removed at the original operation; and if so, the prognosis of the case would be more favorable

than it would otherwise be. It may be that such recurrence is due either to some local or lymphatic infection, or to both. Under all circumstances, however, if recurrent growths can be removed they should be so treated.

When only such portions of breasts as seemed affected with scirrhus were removed, what were called recurrences were frequent. Such growths were, however, wrongly named, for they would now be called by surgeons continued growth of pre-existing carcinomatous centres; and in past years when the lymphatic glands were neither removed when they were markedly enlarged, nor looked for by an incision when apparently free from enlargement, the same remarks are applicable. True recurrence, when not explicable by either of these methods, can only be explained by either the appearance of a fresh focus, or by a dissemination of the local disease by a more obscure local or lymphatic infection.

Cases Unfit for Operation.—An operation on the breast, as in other cases, may be inexpedient from either local or constitutional causes. Cases in which the disease cannot be entirely removed should be left alone; as well as those in which the disease can be wholly removed, but the patient, either from age or general condition, induced by any cause, is too feeble to undergo the ordeal of an operation.

Locally, tumors that are fixed firmly to the pectoral muscle and parts beneath; tumors complicated with lymphatic glandular troubles which cannot be eradicated, more especially enlarged glands above the clavicle; tumors associated with œdema of the arm on the affected side, as well as those with secondary external or internal metastatic growths, are not to be interfered with.

Cases of brawny carcinoma had better not be touched; nor had those of atrophying scirrhous or other varieties of the disease which are associated with the presence of tubercles more or less diffused about the skin. Cancer *en cuirasse* should never be interfered with.

To gain a good idea of the effects of operation in cancer of the breast upon the duration of life, a statistical comparison of the two classes of cases, that is of those operated upon and those left alone, must be made. In a former page (159) I gave a table of my own, showing the results of operation, and compared it with a second of Sir J. Paget, composed of cases in which no operation was performed.

I give here Gross's statistics upon the same question, he being the most recent writer upon the breast.

I have embodied his conclusions in the following table, which tells strongly in favor of operation:

	Not Operated Upon.	Operated Upon.
Died in between 5 and 12 months,	30.8%	10.5%
" " 12 " 24 "	37.7	33.
" " 24 " 36 "	11.3	24.
" " 36 " 48 "	9.8	9.9
" " 48 " 60 "	7.9	7.9
" " 60 " 72 "	3.4	5.
" " After 6 years	1.2	9.5
Average duration of life,	27 months.	39 months.

(One year being added to life by the operation.)

Velpeau stated in 1864, at the French Academy of Medicine, that out of 250 cases in which patients had survived the operation of amputation of the breast, twenty, or one in twelve and a half, had remained free from disease for more than five years, some few having been so for ten or twenty; and these operations must have been what would now be called incomplete operations, for before and at the date named the lymphatic glands were rarely touched.

Nunn likewise states that one case in thirteen on an average lasts from ten to twenty years.

Compared with these results, my own table is very favorable, for at least one-fourth of the cases lived from five to ten years or more. But it must be remembered that in at least a third of these cases the major operation of the complete removal of the breast and lymphatic glands was carried out.

I have been unable to make from my own cases, as Gross has made from his, a comparison between cases that have been operated upon, and those that have run their natural course, the difficulties of tracing patients who have not been submitted to operative treatment being greater than in those who have. My own table of operative cases, however, fairly supports Gross in showing the good effects of operation, and I think more forcibly, for in mine at least 14 per cent lived over six years against his 9.5 per cent, and 25 per cent lived over five years against his 14.5 per cent.

Life is therefore probably prolonged by operation, and more particularly by what must be described as a complete operation; indeed, by such a measure, even where it includes the removal of the cancerous breast, with its infected lymphatic glands, a permanent recovery may, in a certain proportion of cases, be looked for. In what exact proportion of cases this result can be secured, it is difficult to say, but if we adopt Gross's method, and assume that when a patient has survived an operation over three years without any local sign or general indication of recurrence, she may be pronounced cured, I do not think his proportion of 9 per cent of all cases is too high. Recurrence may, however, take place at a date long after three years, consequently Gross's view can only be an average one.

At page 164 a case is recorded in which, after operation, no recurrence took place for twenty-five years, and on looking over my notes I read the case of a woman, aged 47, who was operated upon after the local disease had existed for two years, who remained well for five years, when a local recurrence took place, and a second operation was performed; the second operation being followed, after the lapse of another five years, with a second recurrence which rapidly grew and destroyed life.

Case II. was that of a woman, aged 50, who, after having been operated upon for a disease of two years' standing, remained well for eleven years; then a local return of her trouble appeared, which was removed, and two years later she was well.

Case III. a patient of Mr. Birkett's, who had her breast removed in 1851, when 67 years of age; she remained well for twenty-three years, and at the age of eighty had cancer of the scar and opposite breast.

Case IV. also a patient of Mr. Birkett's, who had her breast removed at the age of 30; thirteen years later the disease recurred in the scar, when a second operation was performed. Two years later a second recurrence was followed by a third operation, and there the record stops.

Case V. In 1876 I removed the right breast of a woman, aged 48, for carcinoma, with a good result, from whom Mr. Hilton had, ten years before, in 1866, removed the left breast for the same disease.

In neither operation were the axillary glands felt enlarged, nor looked for by an exploratory operation. In 1879 the woman was well.

Gross gives, moreover, a table of forty-seven cases which he regarded as cured.

14 of these had been free from disease after operation for 3 years and some months.

18	had been well	from	4	to	6	years and some months.	
7	"	"	6	to	9	"	"
5	"	"	9	to	12	"	"
3	"	"	12	to	15	"	"

The average time of cure was five years and nine months, and the disease had existed before operation on an average of eighteen months.

Mitchell Banks[35] more recently has given us a table of complete operations in which the primary tumor and lymphatic glands were freely removed. Seventeen out of sixty-four cases are reported to have been alive, and to have remained free from the disease for three years and upward, five having been well from three to four years; three from four to five years; three from five to six years; two for six years; two for eight years; one for twelve years; and one for thirteen years.

This advantage of operation is further seen when it is undertaken early. That a woman would have a better chance of gaining the full advantage of an operation for cancer when it is performed before lymphatic infection has taken place, is only what might be expected; the facts of Winiwarter and Oldekop partly prove this to be the case. "Thus, of 136 patients subjected to operation, 43, or 31 per cent, were free from glandular complication, and their average duration of life from the first observation of the disease to the fatal issue was 52.7 months; whereas of the ninety-three cases in which the lymphatic glands were enlarged and removed with the breast by operation, the average duration of life was only 39.3 months, or 13.4 months less than the more favored class. In the uncomplicated cases recurrence of the growth averaged eight months, in the complicated 1.9 months." The major or more complete operative measures apparently have done little or nothing in the way of postponing recurrence of the disease.

Gross adds that nearly one-third of the patients who had

been subjected to the radical operation were free from disease after the lapse of six years, while of the patients in whom no operation was practised only one survived that period.

Local Recurrence after Operation.—That this is to be expected general experience justifies, but at what period it may be looked for is most uncertain. Gross reports that of 368 patients operated upon, all but seventy-two had recurrences; that is, in four cases out of five recurrence is to be looked for. It would have been interesting to know in how many of these 368 cases the complete operation had been carried out. Winiwarter and Oldekop go further, and by an analysis of 203 cases demonstrate that:

In 39	cases	it	occurred	within	15	days.		
" 50	"	"	"	1	month.			
" 38	"	"	between	the	1st	and	4th	month.
" 18	"	"	"	4th	"	6th	"	
" 16	"	"	"	6th	"	9th	"	
" 19	"	"	"	9th	"	12th	"	
" 9	"	"	"	13th	"	18th	"	
" 6	"	"	"	19th	"	24th	"	
" 3	"	"	"	25th	"	30th	"	
" 3	"	"	"	31st	"	36th	"	
" 2 after 3 years.								

From this table it is evident that in more than half the cases a recurrence takes place within three months of the operation; in a quarter of the cases recurrence may be looked for between three and twelve months; whereas in the remaining fourth the recurrence may be looked for at any time during the three years. After this time it is not to be expected, and it is to hoped that the patient may be regarded as cured.

The longer the interval between the primary operation and the so-called recurrence, the better the prognosis. The surgeon should always look upon cases of so-called recurrence within three months as probable instances in which some portion of the growth, or some of the lymphatic glands had been left behind; in fact, he should regard them as examples of continued growth of some overlooked carcinomatous centre.

When a cancerous breast is alone removed, writes Gross, recurrence is to be expected on an average of 3.1 months; when it, with diseased axillary glands, is taken away, that is,

when what is called the complete operation is performed, recurrence of disease averages 7.5 months; the more severe or complete operation apparently not doing much more than postpone recurrence for a few months.

It would seem from Winiwarter, Oldekop, and Henry's statistics, that half the patients that die from cancer do so from metastatic deposits, while the other half die from the baneful effects exerted upon the nutrition of the patient without cancerous degeneration of the viscera.

These authors compute the average date of death from metastasis from the first appearance of the disease at 31.2 months, or fifteen months after lymphatic infection; metastasis may occur from five months to eight years.

Metastatic Deposits.—To demonstrate the relative frequency of the seats of secondary deposits, Gross has compiled a table from his own cases, added to those of Arnott, Henry Morris, and Clark, published in the 27th volume of the Transactions of the Pathological Society of London, p. 264, in this way tabulating 128 post-mortem examinations, from an analysis of which he shows that secondary tumors were found in the

Axillary glands in	115	cases or	89.%	
Other	"	30	"	23.	
Lung	"	28	"	22.	45
Pleura	"	30	"	23.	
Pericardium	"	3	"	2.3	
Peritoneum	"	3	"	2.3	
Brain	"	3	"	2.3	
Œsophagus	"	1	"	0.78	
Stomach	"	5	"	3.9	
Jejunum	"	1	"	0.78	
Liver	"	55	"	43.	
Pancreas	"	1	"	0.78	
Spleen	"	3	"	2.3	
Kidney	"	5	"	3.9	
Adrenal	"	2	"	1.5	
Ovary	"	7	"	5.4	
Uterus	"	2	"	1.5	
Bladder	"	1	"	0.78	
Bones	"	9	"	7.0	
Muscles	"	2	"	1.5	

He then concludes that when left to itself, carcinoma inevitably kills by its baneful consequences as a local disease, or by its remote multiplication.

That about one in six, or 16.7 per cent, of the patients die of the operation itself, but that the risk is not so great as to forbid interference, since it adds twelve months to the life of the patient.

That thorough operations definitely cure 9 per cent of all patients, or more than half as many more as it destroys.

That the patient is safe from reproduction if three years have elapsed since the operation, and that, finally, recurrence may be delayed for several months, or be prevented altogether, by clearing out the axilla at the same time that the entire breast is removed.

Gross maintains, moreover, that the proper measure is to remove the entire breast and its coverings by a circular incision, search for any outlying lobules that may be disseminated throughout the mammary region, dissect off the fascia of the pectoral muscle, and prolong the outer portion of the incision into the axilla, with a view to its thorough exploration. "Experience shows, first, that the seats of recurrence, or rather further spread of the disease after operation, are the skin, paramammary fat, remains of the mamma, and glands of the axilla; and, secondly, that recurrence in the axilla is far more frequent after removal of the breast alone than when that cavity was freed of its contents simultaneously with the extirpation of the breast."

That excision of the breast, with the axillary lymphatic glands, is a graver operation than excision of the breast alone, is what might be expected. Thus, an analysis of cases made by Dr. Stettegart [36] shows that of 264 cases in which the breast and axillary glands were removed, 61 cases, or 23 per cent, died; while of 130 cases in which the breast alone was removed, 10 cases, or 7.7 per cent died, the mortality of the complete operations being three times as great as of the incomplete.

This mortality, moreover, is evidently relatively greater, since it must be admitted that the complete method of operating in breast cases has only come into vogue during the last few years, when the treatment of wounds generally has been far more successful than it was in previous years.

The question before us consequently is evidently this: Can

the more severe operations on an average show either a definitely longer interval from recurrence, or a larger proportion of substantial cures? If experience can answer either of these questions in the affirmative, the surgeon is then justified in submitting his patient to the graver ordeal; if otherwise, is this the case?

As regards the recurrence of the disease after operation, Gross has shown that while in the minor measure of removal of the breast it is to be looked for on an average in about three months, in what is called the complete method it ensues in about seven and a half months. He, however, at the same time, believes he has shown that life is prolonged by this operation about one year.

In my own practice I have not, as a matter of routine, explored every axilla for enlarged lymphatic glands, and particularly in thin women, in whom, under an anæsthetic, the condition of the axillary glands can fairly be ascertained by manipulation. I have, however, always done so when enlarged glands could be made out, and when manipulation was difficult and its conclusions uncertain. I have had no reason to find fault with the results of my practice.

Out of 56 complete operations, private and public, performed, with all the advantages of improved wound treatment, I have lost 4, or 1 in every 14 cases, or 7 per cent; whereas, on referring to former times, when the condition of the axillary glands was only surgically considered when their enlargement was manifest, and wound treatment was as a whole less successful, I lost 8 out of 120 cases, or 1 in 15 cases, or 6.6 per cent.

It is true that the causes of death in both classes of cases can in a measure be explained away, and evidence brought forward to suggest that the operation in at least half the cases had little or nothing to do with the result. I have no intention, however, to do this, as the ultimate issue of the question must turn upon the main facts. Could a carcinomatous tumor always be removed in its early infiltrating stage, that is, when the disease is local, cures may be hoped for. When it is taken away after it has advanced and spread by lymphatic infection, the chances of a complete cure are remote. Other things being equal, free excision is more likely to cure. But are they equal if the mortality of the complete measure is in excess?

When this operation of removal is called for, it should, therefore, as a rule, be complete; that is, not only the tumor should be removed, but the whole mammary gland in which it is placed, with all affected or possibly affected skin and fat about it; but the practice of exploring an axilla as a measure of routine should not be followed, since it is without doubt a graver measure to the patient, and the advantage which it in theory possesses is not yet proved.

The removal of a breast for cancer is often expedient and necessary for purposes of relief rather than of cure; and a breast may often be removed with this object when the exploration of the axilla is neither called for nor justifiable. The surgeon's judgment in this matter is wanted in each case as it may come before him, and he is not to be governed by a dogmatic rule which experience soon proves is not a safe one.

A series of cases could readily be given by one surgeon to show the advantages of the complete measure; while another, or possibly the same surgeon, could give another series equally striking, to demonstrate the value of the so-called incomplete. A measure which is right and justifiable in one case may be wrong and unjustifiable in another. An operation which offers a prospect of cure, and removes what is a source of mental and bodily worry, should always be performed in preference to any partial measure, unless the general condition of the patient is such as to lead the surgeon to believe that any extra risk is incapable of being borne with safety. The advantages of the graver operation are not, however, so certain as to justify increased hazard to life.

On Excision of the Breast.—There is, in average cases, no great danger attending excision of the breast beyond that which accompanies any, even the smallest, operation. In feeble and aged subjects there is, however, much risk, and a certain proportion of cases may be expected to sink after the operation from pyæmia, erysipelas, or visceral disease, since these contingencies attend any operation or wound. From my notes of hospital operations on the breast for cancer, or rather of 200 consecutive cases, only 10 died from pyæmia, pneumonia, or erysipelas, the mortality being but five per cent, and these causes are yearly diminishing. Out of 176 cases in my own practice the mortality was 12, or 7 per cent. Gross gives a mortality of 16 per cent.

In operating for cancer it is unquestionably the wisest course to excise the whole gland. It is well not to be over-anxious about preserving too much integument, and if any doubt exists as to its perfect healthiness the suspected portion had better be excised. When enlarged lymphatic glands clearly exist they should be taken away, and in most other cases where their existence is suspected the axilla should be explored. It is always important, when dissecting out the tumor, to keep clear of all diseased tissues, and, in fat subjects, to take away much of the fat, since there is good reason to believe that an early return of the affection is too often to be explained by want of attention to these points. When the pectoral muscle is infiltrated it must be freely excised. The pectoral fascia should be closely inspected, since in it small cancerous nodules are often found, which, if left, would have been the centre of new growths.

The Operation.—In the removal of a breast the patient should be placed on her back with the shoulder of the affected side raised by a pillow, and the arm drawn out at a right angle to the body.

The incision should be elliptical, and made in a line parallel with the fibres of the pectoral muscle. When the skin is diseased and has to be removed, the incision may have to be circular, and bleeding is to be controlled by the pressure of the fingers of an assistant, or by torsion. The outer or pectoral incision should first be made, and carried well down to the free border of the pectoral muscle, the definite form of which is the best and surest guide to the base of the gland. The inner or sternal incision may then follow. The whole tumor should then be excised and dissected away, a few touches of the scalpel clearing it off the pectoral muscle. The axillary angle of the tumor should be divided last, as it usually contains the lymphatic cords and chief vessels that supply the gland. The incision can be extended upward into the axilla along these cords to explore or remove the glands. When this is done an incision at right angles to the wound backward is good for drainage purposes (Fig. 6). All bleeding vessels should be twisted, the surface of the wound cleaned with iodine water (℥ ij. ad Oi.), carbolic acid lotion (℥ iv. ad Oi.), bichloride of mercury (gr. x. ad Oi.), or chloride of zinc (gr. xx. ad ℥ i.), its edges well adjusted, a drainage tube in-

troduced at the most dependent part, and steady pressure applied by means of pads of antiseptic lint, gauze, or cotton wool, the wound being treated on ordinary principles.

The axillary glands should be removed more by enucleation with the fingers and a blunt dissector than by the knife; by care and a little patience this may usually be accomplished with safety. The surgeon must be careful not to draw too much upon the axillary mass where such exists, for by so doing he will probably drag the large vessels, and more particularly the veins, out of their position, and expose them to

FIG. 6.—Excision of the Breast.

injury. All parts that are cut through should be ligatured first, and then divided on the distal side of the ligature. Banks advises that the axillary vein should be first exposed, after which no danger of wounding it will be experienced. Should the vein be wounded it should be tied.

Beyond satisfying myself that the drainage of the wound is satisfactory, I rarely remove the first dressing for three days, when, in favorable cases, what part of the wound was wanted to heal by quick union, has repaired, and the open surface is granulating. This I wash with iodine water, and dress with lint or iodoform gauze, soaked in a mixture of one part terebene and three parts olive oil, covering in the whole

with a sheet of Gamgee tissue. By these simple measures repair is carried out.

The essential point the surgeon has to observe in the operation is thoroughness; with this, success may be hoped for and reasonably expected; without it failure and disappointment must be the result.

Inadequate and too late operations have doubtless been the cause of many of our failures, and these again explain why it is that some practitioners refrain from advising operative interference, and consequently prevent their patients from seeking early surgical help.

When the profession, as a body, is led to look upon cancer of the breast in its origin as a local disease, and consequently one to be treated early; when surgeons are bold enough to advise, in early doubtful cases, an exploratory incision into the growth with a view to its excision should the disease be found to be carcinomatous, better results will be obtained. Excision is likely to be most successful when applied in the stage which precedes that of lymphatic infection, and when the cancer may be regarded as a local affection. Those who come after us will doubtless have to record better and more encouraging results than I can adduce in these pages.

On the Treatment by Caustics.—This form of treatment has its place in surgery, but it is not to be considered in competition with excision, since by excision alone can the whole disease be taken away with the greatest certainty, and in the shortest possible time.

Caustics are, however, useful in open cancerous ulcers, that cannot be excised, with the view of checking growth, preventing fœtor, lessening discharge, and diminishing hemorrhage.

A paste consisting of one ounce of a liquid extract of the sanguinaria canadensis, made by boiling down a decoction of the root, in which the same quantity of the chloride of zinc is dissolved, and then mixed with two ounces of the extract of stramonium, is very good; and so is the paste used at the Middlesex Hospital, made by mixing chloride of zinc and boiled starch with laudanum, till it reaches the consistence of honey. At the Middlesex Hospital, where this method of treatment is practised more frequently than elsewhere, Mr. H. Morris tells me it is carried out as follows: The whole cutaneous surface of the breast to be removed is first destroyed by the action of

fuming nitric acid applied by a glass brush; and in doing this, care is called for to guard against the effects of any running of the acid over the surrounding parts by the application of some grease, and having at hand an alkaline lotion to neutralize the acid.

When the skin has been destroyed, as indicated by its parchment-like feel and bloodless aspect, multiple incisions well into its substance should be made radiating from the nipple; the surgeon taking care not to cut so deeply as to draw bood.

Into the furrows thus made in the dead skin strips of finely prepared lint should then be pressed, the caustic paste having been previously spread upon and well pressed into its meshes, and all redundant paste scraped off; the object of this being to prevent the paste running over healthy tissue and causing distress. The breast should then be covered with cotton wool and a bandage.

In a day or two, when the caustic has done its work, the strips of caustic lint should be removed, the furrows in the breast deepened by fresh incisions, and strips of lint, prepared as before, applied. The same care being observed by the surgeon in his incisions not to draw blood.

By a repetition of this process every two or three days a breast may be removed in about three or four weeks, and, it is said, with but little pain.

Upon this point I am unable to speak from experience, as I have never removed a whole breast by this means. In some cases, painting an ulcerated surface over with liquefied carbolic acid is of great value, the acid acting as a caustic, disinfector, and anæsthetic at the same time.

Of late years Esmarch's powder has been much advocated, and I think with justice. It is said to be painless. It is made by mixing one drachm of arsenious acid with the same quantity of sulphate of morphia, eight drachms of calomel, and six ounces of powdered gum arabic. The surface of the sore is to be thickly sprinkled daily with this powder till a crust forms, and repeated if necessary.

As an ordinary application to a cancerous sore where these severe caustics are not employed, I find an ointment made of two drachms of resorcin with six of vaseline is very good. I have thought that it dissolved the epithelial structures, and

1. Cystic Disease with discharging Nipple.
2. Cystic Sarcoma.
3. Cystic Sarcoma bursting through Coverings.
4. Cystic Carcinoma.
5. Lipoma.
6. Chondroma.
7 & 8. Hydatids.
9. Cystic Degeneration of Breast with sarcomatous Growths.

consequently tended toward a cure. I have, in a few cases, used resorcin as a powder, dusted over a cancerous surface, and with advantage. I have thought it tended to bring about its disintegration.

Injections of acetic acid into cancerous growths cannot be said to be quite useless, since, in one case already quoted (page 210) the injections brought the mass away; but their effects are so uncertain and unsatisfactory, that they are not to be relied upon, and by their use valuable time is lost.

When no local treatment of any special character is employed, and the disease must be left to take its course, pain must be assuaged by the internal or hypodermic use of morphia in one of its forms, the bimeconate being the best; or the local application of a drachm of the extract of belladonna, rubbed down with one ounce of glycerin, or of the extract of stramonium; or of an ointment containing a tenth part of cocaine. As a painless deodorizer, Gross speaks highly of a mixture of five grains of chloral hydrate to one ounce of vaseline.

Should great activity be displayed in the local disease, as indicated by extreme capillary injection and warmth, the local use of cold gives comfort and checks growth. This may be effected by means of one of Leiter's metallic coils or ice bags, and when these are inapplicable, by the employment of the usual lead lotion mixed with opium.

In foul cancerous ulcers a powder of fine iodoform or iodol mixed with boracic acid, in the proportion of one to four, is to be recommended; and in very painful sores cocaine used as an ointment or in solution, of about half a drachm or drachm to an ounce, gives comfort. Hamamelis has been strongly advocated as an application to open cancer. I have, however, failed to find its advantages.

Should local bleeding occur, a pledget of lint, soaked in a concentrated solution of alum, or of dried cotton wool which has been steeped in a solution of the perchloride of iron, will probably suffice to check it. The glycerin of tannic acid, applied on lint, is also under these circumstances useful.

CHAPTER XV.

A SERIES OF CASES ILLUSTRATING THE CLINICAL SYMPTOMS AND TREATMENT OF CARCINOMA OF THE BREAST. EACH CASE ILLUSTRATES A POINT.

CASE I.—Carcinoma of the breast, unrecognized in its early infiltrating stage; subsequent excision and recovery.

Mary A. C., a healthy-looking single servant, aged 37, came under my care on March 31st, 1877, with some swelling of her left breast. Her mother, maternal grandmother, and aunt all died of cancer of the womb; father alive and well. For three months she had had shooting pains in her left breast, and for one month had noticed that it had become hard and tender. She thought also the nipple was retracting. When I saw her, one lobe of the gland was certainly slightly fuller and harder than the other; it was likewise very tender to the touch. The nipple was not to any degree more retracted than that of the opposite breast. The skin over the breast was natural, and the axillary glands free. I was disposed to look upon the case as one of irritable mamma, and treated it accordingly. In a year she reappeared with a typical carcinomatous tumor, as indicated by a hard nodulated swelling in the position of the former tender and slightly hardened lobe; adherent puckered skin over the tumor, well-marked retracted nipple, and enlarged axillary glands.

I then removed the breast, tumor, and axillary glands, and a good convalescence followed. Four years later this patient was well.

Remarks.—In this case an exploratory incision into the growth when first seen would have saved delay and a surgical error, although the subsequent progress of the case has been one of hope. It tends likewise to support the practice of making an exploratory incision into any doubtful tumor of the breast when first coming under observation.

CASE II.—Carcinomatous tumor attached to margin of

breast, simulating adenoma; excision of tumor; patient well three years subsequently.

Catherine C., a married woman, 33 years of age, the mother of five children, came under my care in June, 1874, with a tumor in her left breast, which had appeared six months previously, when she had given up suckling her last child. The tumor had grown slowly since, and when seen was the size of a hen's egg. It was situated at the sternal margin of the left breast, and was hard, nodulated, and very movable. The skin over the tumor was free and natural; the nipple was normal; axillary glands natural. The growth was regarded as an adeno-fibroma and removed, the breast itself being left. A good recovery followed the operation, and the patient was well three years subsequently. A section of the tumor, and a careful examination of its structure, proved that it was an example of scirrhous carcinoma.

I regretted at the time that the whole breast had not been taken away. The last report of her case was, however, that she was well three years later, and under such circumstances the feeling of regret has disappeared. The tumor must have been, when removed, a local disease.

Case III.—Carcinoma of breast; dimpling of skin; excision of growth; recovery.

Mary A. T., a healthy-looking, childless, married woman, aged 30, came under my care on April 11th, 1881, with some thickening of the clavicular lobe of her left breast, which had been coming on for four month, after a blow. The tumor was ill defined and firm, but not so hard as scirrhus generally is; indeed, from its hardness alone no diagnosis could be made, particularly as the nipple was natural and there were no enlarged axillary glands. The skin over the tumor was, however, slightly dimpled; with this symptom the diagnosis was made, and the breast and tumor first incised and then excised. The disease was clearly on section carcinomatous. A good recovery followed.

In this case the value of the dimpling of the skin over a doubtful tumor was well displayed, since it enabled a definite diagnosis to be made as to the nature of the growth, and active treatment to be based upon it. Had this dimpling not existed, an exploratory incision into the tumor, for diagnostic purposes, would have been called for, prior to its excision.

CASE IV.—Carcinoma of breast; painless progress; tumor and dimpling of skin; nipple natural; operation and recovery.

Susan V., a childless married woman, aged 58, came under my care in April, 1873, with a hard, nodulated tumor of the upper segment of the right breast, about 2½ inches in diameter, which had been slowly growing for two and a half years, and absolutely without pain. The nipple of the gland was natural; the axillary glands were not enlarged, but the skin over the tumor was dimpled. The breast and tumor were excised, and a good recovery ensued.

CASE V.—Carcinoma of breast and axillary glands; skin over tumor and nipple natural; excision of disease; recovery; five years later the patient was well.

Eliza H., aged 42, the mother of four children, all of whom she suckled without trouble, came under my care on March 14th, 1872, with a tumor the size and shape of a small orange, in the axillary border of her left breast, and a mass of enlarged axillary glands beneath the anterior border of the pectoral muscle. The tumor and breast moved freely over the parts beneath; the skin over the tumor was normal and quite free; the nipple was natural. On March 22d the breast was removed and the axilla was cleared out. Recovery followed, the woman being well five years subsequently.

CASE VI.—Carcinoma of the breast; attention drawn to part by retracting nipple, not from pain; operation.

Eliza J., a thin, healthy-looking woman, aged 60, the mother of six children, came under my care on January 6th, 1883, for a tumor in her left breast. She had had no pain, or even discomfort, in her breast, and her attention was first drawn to it by a nurse who, when dressing her, observed that the nipple was retracting. This led her to see her medical man, who sent her to me, when I found a small typical carcinoma fibrosum, as indicated by a stony nodular infiltration of the whole breast, with retracted nipple, and puckered integument over the tumor. The lymphatic glands were not involved. As the patient was thin, and apparently a good subject for an operation, and the disease seemed to be quite local, I excised the gland, and a good recovery followed. The axilla was not explored. The patient was seen eighteen months later, and she was well.

CASE VII.—Carcinoma attacking breast at the seat of an

old abscess; nipple retracted; skin and lymphatic glands uninvolved; operation; recovery.

Emma C., aged 59, the mother of two children (the youngest twenty-eight years of age) came under my care on May 17th, 1880, with a tumor in her left breast. When suckling her last child, twenty-eight years previously, she had an abscess in her left breast. Eight months ago she found a lump situated in the breast beneath the scar of the old abscess, and this lump has steadily increased, although without pain. At present there is a hard, nodulated swelling, the size of an orange, upon the upper and sternal segment of the left breast. The tumor is clearly in the gland, which moves with it over the deep parts. The skin over the tumor is healthy and movable, except where the old scar of the abscess exists. The nipple is much retracted; the lymphatic glands are apparently uninvolved. May 21st, the breast and tumor were removed, and a good recovery followed. The tumor was a good specimen of carcinoma. I have been unable to trace the later history of this case.

CASE VIII.—A carcinomatous tumor attached to the upper border of right breast following a blow; excision of tumor; patient well four years later.

Eleanor C., a childless widow, aged 40, came under my care in March, 1874, with a tumor four inches square, attached apparently to the upper margin of the right breast, although not in the breast, which seemed quite normal in all ways. The tumor had been growing for thirteen months, and had followed a blow received one month previously. It had grown slowly, and when seen was somewhat fixed, although movable upon the parts beneath; the skin over it was infiltrated, red, smooth, and part of the tumor. The axillary glands were free. On March 17th, I excised the tumor and skin over it, leaving the breast, which did not seem to be involved. A good recovery followed, and four years later this patient was still well.

CASE IX.—Carcinoma of left breast; sloughing; operation and removal of axillary glands; relief.

Mary B. J., aged 55, the mother of two children, came under my care on October 3d, 1883, with a large fungating, bleeding, carcinomatous growth, involving the nipple and the whole of the left breast; also the axillary glands. It was movable upon the deeper structures. The disease had existed for six

years, had grown slowly for five, more rapidly for one. Nine months before admission into Guy's Hospital it began to break down, and for three months it had bled. On October 9th, I removed the whole mass, with the axillary glands, and a good convalescence followed. Some months later she was well, and had greatly improved in her general condition.

CASE X.—Carcinoma of both breasts; excision of both at an interval of two and a half years; convalescence.

Harriet W., aged 60, a governess, came under my care in March, 1884, with a well-marked carcinoma of her left breast, of eight months' standing. It was the size of a walnut, and was placed on the axillary lobe of the gland. It was movable over the deep parts, and the skin over it was neither fixed nor dimpled. The nipple was retracted; axillary glands free. Two and a half years previously she had lost her right breast for an open cancer of many months' standing. On March 28th, I removed the tumor and breast, and a good recovery followed. The breast had almost disappeared by atrophy.

CASE XI.—Carcinoma of the breast, axillary glands, and skin, with discharge from nipple; operation; recovery.

Mary M., a married woman, aged 48, the mother of three children, all of whom she had suckled, came under my care in September, 1874. Her grandmother had died of tumor of her breast at the age of 79. Her mother was alive and well. The patient had discovered a lump in her right breast about one year before admission, and at the same time a swelling in her right arm-pit. There was no pain in either swelling for some months, but for about six months pain appeared as the swellings increased in size. When seen there was a dense, hard, nodular swelling in the upper half of her right breast. The skin over the swelling was pitted like the rind of an orange, and adherent to the tumor beneath. The nipple was drawn inward, and on pressure over the tumor a clear brown fluid exuded from the nipple, which, when tested, was highly albuminous. In the skin above the tumor was a single, red, hard tubercle, which the patient said had followed a poultice; the axillary glands were enlarged, but movable.

On October 6th, the tumor, with the breast, skin over it, and axillary glands, were removed, a good recovery following. Sixteen months later the woman was well. The tumor was a good example of scirrhous cancer.

CASE XII.—Rapidly growing tuberous carcinoma of the breast with all the well-marked symptoms; operation; recovery.

Emma P., a healthy-looking woman, aged 39, the mother of four children, all of whom she suckled without trouble, came under my care on March 12th, 1879, with a hard, nodulated tumor, measuring five inches by three, in the outer side of her right breast, to which the skin over it was attached by infiltration. The nipple was likewise retracted, and the axillary lymphatic glands enlarged. The tumor was first discovered only three months before, when it was the size of a walnut, the breast and nipple at that time appearing to be otherwise natural.

On March 18th, the breast tumor and axillary glands were cleared away, the patient making a good recovery. The specimen removed was an excellent example of rapidly growing soft cancer. It was soft, highly vascular, and lobulated, although clearly infiltrating the breast structure. No subsequent history of this case can be obtained.

CASE XIII.—Carcinoma of the breast; slow, and later on, rapid growth; radical treatment with good result.

Mary M., aged 57, the mother of eight children, the youngest being 20 years of age, came under my care in April, 1876, with a hard, nodular tumor, measuring four by five inches in diameter on the outer and lower segments of her right breast. The skin over the tumor was "puckered," the nipple retracted, and the axillary lymphatic glands enlarged. The tumor had been growing for nearly three years, although for two and a half years its increase had been slow; since then it has grown rapidly. At first it was the seat of occasional pain; for the last six months the pain has been acute. The nipple was unaffected up to three months ago, when it began to retract; at the same time the skin over the tumor became dimpled, and later on puckered to the parts beneath. The axillary glands became likewise affected.

On May 2d, the tumor, with the breast and axillary glands, were cleared away, and a good result followed. The patient was well a year later. The history of this case illustrates two different conditions. The first one of slow and inactive growth; the second of rapid and active increase of the original tumor, and local and lymphatic infection of other parts.

Case XIV.—Carcinoma of the breast accompanied with severe pain; enlargement and resolution of lymphatic glands; operation; recovery; well three years later.

Ann N., aged 51, the mother of nine children, came under my care on February 10th, 1882, with a tumor the size of an orange, in the upper half of her left breast. It had been growing for three years, and for the first two and a half years gave but little trouble; for six months it had increased rapidly, and was the seat of severe pain. Three months previously the axillary glands enlarged, but they subsided under treatment. On admission the tumor is very hard; it has a smooth outline, and the skin over it is "puckered." The nipple is retracted. No enlarged lymphatic glands are to be felt. On February 14th, the breast and tumor were removed, the axilla was explored without result, and the case did well.

The tumor on section presented in its centre all the features of true scirrhus; around its periphery it formed a good example of the more rapidly growing and softer medullary cancer; the tumor exhibited at the same time the microscopical appearances of the slow and rapidly growing varieties of carcinomatous disease. In 1886 this patient was well.

Case XV.—Tuberous carcinoma of breast with infiltrated skin; natural nipple; enlarged axillary glands, following a blow, associated with albuminuria; no operation.

Maria R., a healthy-looking old woman, aged 72, came under my care in April, 1884, with a tumor in her right breast. She was a married woman, and had had eight children, all of whom she had suckled without trouble. She had always enjoyed good health. Five years ago she struck her breast severely against the corner of a washing tub; swelling and pain followed, and when the immediate effects of the injury had subsided, a lump remained. Six months ago this lump suddenly began to enlarge and became the seat of pain; for this she sought advice. Her family history was good.

When seen a tumor the size of a tea-cup occupied the upper and outer segments of the right breast. The skin over it was part of the tumor, and was red from congestion, fixed to the growth, and hard. It was in parts slightly œdematous. The nipple was natural. The axillary glands slightly enlarged. The breast and tumor moved freely over the pectoral muscle. Pulse good. Urine, specific gravity 1012, contained albumin. Under these circumstances no operation was advised.

CASE XVI.—Carcinoma of the breast with tuberculated skin and carcinoma of spine; no operation justifiable.

Eliza R., aged 44, a single woman, came under my care on May 1st, 1877, with a tumor about two inches by one and a half in the right breast, which had been growing for about five months. When first discovered it was the seat of an occasional shooting pain. The tumor was hard and nodulated, and clearly formed part of the breast. It moved freely with the breast over the deeper parts. The skin over it was "puckered," and in it were many pea-like tubercular cancerous infiltrations. The nipple was retracting, and the axillary glands were unaffected. About six weeks before admission she became lame in the right leg, and pain passed from the loins down the leg. This so increased in severity that she was unable to walk, and sometimes in her sleep her right leg started.

On admission she was unable to sit up without experiencing great pain in her back from the mid-dorsal region to the sacrum, and there was tenderness on pressure over this region, and over the right sciatic nerve. She could flex the right thigh partially, but she could not lift the leg from the bed. There was no loss of sensation in the limb. With these symptoms it was assumed that secondary disease existed in the spine, and no operation was advised.

CASE XVII.—Carcinoma of the breast; tubercular infiltration of the skin; ulceration of the skin; no operation justifiable.

Eliza G., a fairly healthy-looking woman, aged 53, the mother of two children, came under my care on June 20th, 1877, with a hard scirrhous tumor two and a half inches in diameter, in the axillary lobe of her left breast, which had been growing for one year. The skin over the tumor, breast, and sternum, was mottled red, as if inflamed, and to the touch was tuberculated, and irregularly infiltrated with carcinomatous elements. At one spot the skin was ulcerated from the breaking down of the skin cancer. The breast was fixed to the deeper parts, clearly from the extension inward of the disease. The axillary glands were likewise infiltrated. The nipple was not retracted.

CASE XVIII.—Carcinoma of the breast of a woman, aged 25, in two separate masses; operation refused.

Mrs. S., aged 25, discovered, in January, 1872, a small lump in the upper half of her right breast, but as it gave no pain she disregarded it. She had been married seven years, but had not been pregnant. When seen in February, 1873, one year after the discovery of the tumor, the upper half of the right breast was occupied with a nodulated mass the size of an orange, which evidently infiltrated the gland with the skin over it, which was puckered. Below the nipple there was a second tumor the size of a walnut, which was unconnected with the first. The skin over it was dimpled. The nipple was retracting, and the axillary glands enlarged. Operation was refused.

Case XIX.—Infiltration of breast following the disappearance of cystic formation; cupping of skin from scar of abscess which existed twenty-two years before.

Susan K., aged 48, the mother of one child twenty-two years previously, when she had an abscess in her right breast, came to me on November 27th, 1865, with great thickening and enlargement of her right breast, associated with pain. The integment over it on the outer side was drawn down to the gland (dimpled). Two years previously this woman had been under my care for two swellings, which were taken to have been cysts, in the same breast, which had disappeared. November 5th, 1866, the left breast became indurated like the right, and this rapidly developed whilst the right remained stationary; nodules appeared also upon the skin. Operation refused.

The cupping of the skin was due to the contraction of the scar of the abscess which had existed twenty-two years before, the enlargement of the breast making the depression more marked.

CHAPTER XVI.

CYSTIC TUMORS OF THE BREAST.

We now come to what is at once the most interesting, and at the same time the most perplexing section of the whole range of diseases of the breast, since it is cystic disease of the gland that, to my mind, makes any pathological arrangement in such a work as this of little utility. It is on this account that I determined in these pages to consider breast diseases purely by the light of clinical experience.

As I have already urged, there are those who, at the present day, treat of cystic disease of the breast as one of the nature of sarcoma. I, on the other hand, contend that this grouping is not right, under the belief that cysts are a part of the pattern or architecture of most tumors of the breast, whatever be their nature, save and excepting scirrhus, and even with this disease cysts are found.

Thus we clinically meet with simple cysts, cystic adeno-fibromata, myxomata, sarcomata, carcinomata, and what not, and it is left, as yet, entirely to clinical experience to say what is the natural tendency of cystic disease.

I shall, in the following pages, describe cases of all these varieties of cystic disease, and I shall, I trust, show that the greater proportion by far of all these cases is, so far as I can learn, cured by free removal; that is to say, that recurrence after such treatment is exceptional.

The bearing and importance of this fact are obvious, for if it be so, there is much reason for insisting upon the restriction of the term sarcoma at the bedside.

Under this heading I propose to group all tumors of the mammary glands made up of cysts, whether those cysts are multiple or single, whether they contain fluid alone, or are more or less filled with adeno-fibromatous, adeno-sarcomatous, or adeno-carcinomatous intracystic growths.

I shall not stop to inquire into the different methods by which the cysts are formed, since I believe it to be impossible clinically to make out, otherwise than in exceptional cases, whether the cysts are due to an obstruction of a galactophorous main or branch duct (retention cyst); or to the exudation of fluid into the intercellular spaces of the connective tissue of the breast (lacunar cysts); or to the growth of papules into a duct or acinus from the connective tissue of the breast and their subsequent junction. Neither can the surgeon speak with certainty in all cases as to the absence or presence of an intracystic growth, nor as to the nature of the growth.

In a large proportion of cases in which the cyst contains solid growth, a diagnosis of its nature can, however, be made, but the diagnosis is then more determined by signs and symptoms other than those associated with the presence of a cyst. To these points attention will be drawn later on.

I would, however, for the sake of convenience and possibly of clearness, divide the subject up into certain sections, and consider:

1st. The cystic degenerations of the breast as met with in the old, as well as in glands which have long ceased to be active; involution cysts as they are called (Plate IV., Fig. 9).

2d. Cystic tumors of the gland, single or multiple, of glandular, duct, or connective-tissue formation without intracystic growths (Plate IV., Fig. 1).

And, 3dly, cystic tumors of the breast of whatever kind in which papillomatous, adenomatous, sarcomatous, or carcinomatous intracystic growths are present (Plate IV., Figs. 2, 3, and 4).

These three classes will be considered in order.

Group I.—The Cystic Degeneration of the Gland as met with either in the Old or Obsolete Gland.

This condition must, without doubt, be recognized, for it is found in the breasts either of the old, or of those in whom the glands have ceased to be active, and are, as it were, undergoing involution changes. Meaning, by this term, involution change, an irregular form of atrophy, a condition to be expected in any tubular or acinous gland, and, as a fact, one

well known in the kidney, the thyroid, and occasionally in the pancreas.

It may be that a single lobe or lobule is undergoing this special form of degeneration, but more probably the change will have affected the whole gland, which, on dissection, will be found to be made up of innumerable small cysts, varying from the size of a hemp-seed (the more common size) to that of a pea, whilst in exceptional cases these dimensions, in isolated cysts, may be considerably exceeded.

The cysts appear more as a series of dilatations of the lactiferous ducts (varicose ducts) than of the gland structure, although in certain cases both ducts and gland structure are involved.

On dissecting these cases and on separating the ducts, or rather unravelling them, the gland as a whole may be involved, and in a dissection I made many years ago, the breast appeared, when suspended by the nipple, to be made up of strings of small cysts connected together by the main and branch ducts. Some of the cysts had direct tubular communication with the neighboring cysts, as proved by the passage of bristles through the ducts from one cyst to another, or by the fact that many of the cysts and ducts could be inflated by means of a fine tube introduced into one or other of the nipple ducts. In many cases, however, this direct communication cannot be made out.

These cysts, when unopened, have usually a greenish or black appearance, and when opened they are found to contain a blackish viscid or mucoid fluid, more or less coagulable by heat, and mixed at times with fat and epithelial elements, such being the products of degenerating epithelium.

The breast, thus affected, feels on manipulation in thin subjects as a coarse gland, with here and there a pea-like tumor, whilst in fat women the change often cannot be clinically recognized.

This change is rarely associated with pain, or with a greater amount than can be described as uneasiness. There is seldom any discharge from the nipple in these cases, although there may be at times. Why there should not be a discharge always can only be explained by the fact that the ducts become obstructed, and probably by their epithelial elements.

In exceptional cases some enlargement takes place of a

single cyst or group of cysts, and under such circumstances a cystic tumor is formed, for which surgical advice is sought. I have seen many of these cases. In some the cyst was single, and relief was given by simply drawing off the fluid by means of a small trocar and canula; in other cases two or more cysts existed; in a few they were still more numerous and showed signs of activity, so that excision of the affected lobule or whole gland was required.

In not a few cases the cysts have become the seat of intracystic, sarcomatous, adenomatous, or cancerous growths, for which extirpation of the whole gland has been necessary. To these attention will be drawn later on.

What I would wish now to be recognized is the fact that there is in the mammary glands which have long ceased to be active, and in those of women past child-bearing, a cystic degeneration of their ducts and glandular structure which may simply remain as such or take on active changes. Under the latter circumstance, a cyst or many cysts may either enlarge so as mechanically to cause trouble or become the seat of intracystic, adenomatous, sarcomatous, or carcinomatous growth which will run the usual course of such tumors.

In the two following cases this cystic involution change is well illustrated. In the first the whole breast was excised, and a good result ensued. In the second some of the cysts were relieved by tapping, when the remainder disappeared. This favorable result is one that not infrequently follows an expectant treatment, but it is not in the majority of cases to be expected. The hope of obtaining such a success by leaving things alone, should not induce the surgeon to withhold his hand in any case in which the breast is clearly enlarging, although it may be sufficient to sanction a watching line of treatment where the progress of the trouble is slow.

Case I.—Involution cysts of breast which had long ceased to be active, simulating cancer; excision of gland; recovery.

Mrs. T., aged 52, the mother of many children, all of which she suckled, consulted me in May, 1885, for some affection of her right breast, which had been slowly coming on for about six months. It began as an enlargement of the axillary lobe, and later on as a swelling of the whole breast. At times there was a discharge of a clear fluid from the nipple and some slight pain.

When seen the whole breast was coarsely enlarged and indurated; one lobe, the axillary, seemed to be generally infiltrated with some new material; the other lobes were full of nodules which appeared to be cystic. The nipple was natural, but pressure upon the breast caused from it a slight discharge of a serous fluid. The skin over the breast was healthy, as were the lymphatic glands.

I regarded the case as one of carcinoma, with cystic degeneration of the gland, and advised excision.

On May 13th, the operation was performed, and a good recovery rapidly followed. This lady is still well.

Description of Breast by Mr. Symonds.—Just beneath the nipple was a cyst, one inch in diameter, with a thick dark wall, imbedded in condensed breast tissue, containing many smaller cysts. Everywhere through the breast these cysts existed, and all were filled with a creamy gray fluid, which exuded as so many beads when the breast was squeezed. The galactophorous ducts were filled with this same material, which exuded from the nipple on compression. The whole organ had a uniformly whitish-gray color, but nowhere was any solid growth visible. The outline of the breast seemed also normal, and there was no infiltration of, or alteration in, the surrounding fat.

Microscopical Examination.—The fluid was not examined fresh, but from its resemblance to that seen in similar cases, and from its appearance in the hardened sections, it, no doubt, was composed of degenerated cells and fatty granules.

The appearances seen in the sections might be shortly described as showing the ordinary breast tissue containing many cysts (Fig. 7). There are groups of small tubes cut in various directions, some having a distinct lumen, many showing only a number of irregular cells. These groups are always surrounded by fibrous tissue containing fat vesicles, and represent the ordinary breast lobules. The adipose tissue is in some places tolerably abundant. Many of these tubes are much enlarged, having a wide lumen, occupied in many instances by granular matter, and lined with two or more rows of cells. As the accumulation of secretion increases, the central aperture enlarges until a small cyst is formed visible to the naked eye. These changes are all obvious in the woodcut below, and occur in all parts of the breast.

Besides these cysts with a round lumen, there are many apertures with a sinuous outline, and many with villi or buds projecting toward the cavity. These are all lined with two or more rows of cells, the inner row being more or less columnar, and taking the stain (logwood) more deeply than the outer or irregular cells. The buds or projections are covered by the same cells, and have vessels and fibrous tissue as a basis. The appearances are shown in the illustration.

Again, the largest cysts have a wall composed of lamellæ of fibrous tissue, are lined by large columnar cells, and contain some of the granular material above described. The

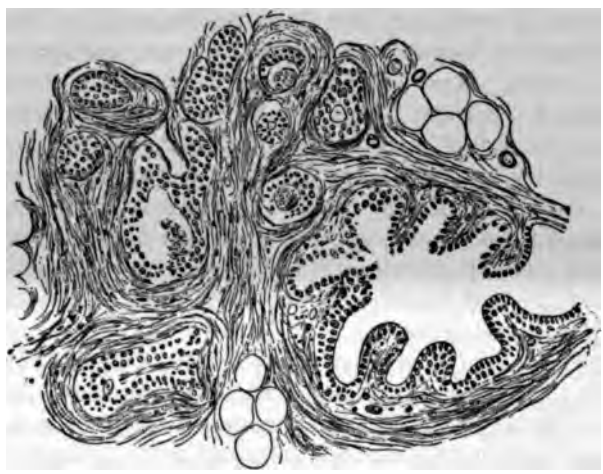


FIG. 7.—Breast undergoing Cystic Degeneration. Case I.

cells form a definite layer much altered from the regular columnar shape by mutual compression; usually the layer is two cells thick, but there is no regularity in the arrangement. The fibrous tissue seems no more in amount than that proper to the breast, the cyst formation appearing to be the only morbid change. From the description given above, and from the appearances presented in the drawing, these cysts all seem to form out of the mammary acini and ducts.

CASE II.—Cystic degeneration of breast which had never secreted milk.

Mrs. S., aged 34, the mother of one child 17 years of age, consulted me in February, 1880, for some disease of her right

breast. She had suckled with her left breast, but not with her right, as that gland had never secreted milk, although it in all other ways appeared to be natural.

Three months before I saw her she accidentally discovered a lump in the right breast, which had steadily increased. It was not the seat of pain, but only of uneasiness. When I saw her there were four or five nodules the size of nuts in the gland, and these, from their globular outline, I took to be cysts. The whole gland felt coarse to the hand, and knotty.

I punctured one of the nodules for diagnostic purposes, and let out some serum. The others I left. Six months later when last seen, there was no change in the breast.

The cysts were doubtless due to cystic degeneration of the gland from involution changes.

Group II.—Cystic Tumors of the Gland; Single or Multiple; of Glandular, Duct, or Connective Tissue-Formation without Intracystic Growths.

That these cystic tumors of the mammary glands are not uncommon in practice must be fully recognized, although it must be acknowledged that they are too often not diagnosed until by some error they have been subjected to surgical operative treatment.

I take it few surgeons have been so fortunate as not to have removed a breast for a supposed cancer which turned out to be a cyst; and fewer still who have not, as spectators of such a case, been well sprinkled with the fluid of a tense cyst, accidentally opened by the hand of a surgeon in his attempt to cut into or excise what he regarded as a solid tumor.

Formation of Cysts.—These cysts are doubtless developed in several ways. Some are unquestionably "*duct cysts*," that is, they are formed first by an obstructed and subsequently by a dilated irritated duct, the duct being more commonly a branch than a main duct, and occasionally a duct leading directly into an acinus of the gland. When the branch is a large one the cyst is likely to be single; when it is placed nearer the gland structure the cysts are more likely to be numerous. The cystic tumor in the former case appears as a globular, tense, more or less deeply placed growth; and in

the latter as an unequal enlargement of one of the lobules of the gland, with a more or less bossy outline and semi-fluctuating feel; this latter symptom turning much upon the size the cysts attain and the depth of gland structure which covers them in.

The fluid contained by these cysts varies much. In the majority of cases it is clear and serous, in others it will be brown or slightly blood-stained, in a few cases it will be viscid and mucoid. When it is deeply blood-stained or sanguineous the surgeon should suspect that it is not a simple but a proliferating cyst in which some intracystic growth exists. In almost all cases the fluid will be albuminous; at any rate, I have not yet met with an example in which it was otherwise. At times fluid may escape naturally or may be pressed from the nipple, and when this takes place the diagnosis of a duct or glandular cyst may with confidence be made. In half the cases of this affection no such symptom will, however, be found, but this fact need not diminish the value of the symptom for diagnostic purposes when it is present.

Others of the cysts have a "connective-tissue origin." That is, they originate outside the ducts of the gland structure, and are formed by the effusion of fluid into the connective tissue which binds the lobes and lobules of the gland together. Such cases are usually single, but may be multiple. They are commonly of slow formation, and as a result have thick walls. They are always smooth on their inner surface, and as a rule contain serous fluid. At times the fluid is, however, mucoid or dark. When the cyst appears in the breast of a thin woman its tense globular outline, unassociated with any of the symptoms which are recognized as characterizing the existence of a cancerous or other tumor, should suggest its nature as well as its treatment, for the puncture of the swelling with a fine aspirating needle will prove much.

When the cyst shows itself in the breast of a fat subject the diagnosis must be difficult, but its true nature should ever be suspected, even when all other symptoms of more solid growths have by the lapse of time failed to manifest themselves. The more breast tissue there is to surround a cyst or cystic tumor, the greater the difficulty of diagnosis. The longer the tumor has existed without the manifestation of the well-recognized symptoms of cancer or other growth, the

stronger the probability of its being cystic. In all doubtful cases, however, the fine exploring needle of an aspirating syringe will avail much for diagnostic purposes. In but few of these cases can the surgeon without exploration diagnose between the simple cyst and the cyst with proliferating intracystic growth. Simple cysts of the breast exist, without in many cases ever developing into anything else, or becoming the seat of solid growth. With the majority of cystic tumors this, however, is not the case, for what may seem to be the most simple or innocuous cyst may be expected, if not cured, to become the seat of some proliferating intracystic growth, which will be adenomatous, sarcomatous, or carcinomatous, according to the tendency of the tissue to form, and of the individual to develop, either special variety.

The mere presence of a cyst in the mammary gland must be accepted as evidence of some unnatural local irritation, inflammatory or otherwise, whether that irritation has originated in, or become localized about a gland duct, lobule or gland, or connective tissue. If the irritation is subdued or subsides, a cure, or at any rate freedom from fresh developments of the local trouble may be looked for; but should the local irritation continue or intensify, fresh developments must be expected, and such of necessity will assume the form of a new growth either of the glandular, epithelial, or connective-tissue type, and lead on to the formation of an adenomatous, epitheliomatous, or sarcomatous cystic growth, to which attention will now be drawn. In rare cases the cyst will suppurate and undergo a spontaneous cure. I propose to illustrate the clinical history of this group of cystic disease by means of cases, each case telling its own tale.

CASE III.—Duct cyst in breast with retracted nipple; albuminous fluid drawn off; cured. (Reported by Mr. H. Caddy.)

Susannah B., a healthy-looking, well-nourished woman, aged 24, was admitted into Lydia ward, under Mr. Bryant's care, on the 9th of September, 1872, with a large hard substance in the centre of her left breast. The nipple had quite disappeared, from retraction, but the swelling seemed to point at the surface about an inch above where the nipple ought to be. There was no glandular enlargement in the axilla or above the clavicle.

The patient's family history had been good, and she herself had been healthy up to thirteen years old, when her back began to grow out both backward and to the right side. She had no remembrance of any injury, and a year later she was employed in turing the mangle.

About four years ago her tonsils were cut, and two years later she felt slight pain in the upper part of her left breast, which became more severe when she raised her arm. One month before admission she noticed a lump about the size of a filbert, which was movable; a fortnight later there was a discharge from the nipple. She then sought advice from a medical man, who told her to bathe it with warm water; this benefited her at first, but the lump grew, and the discharge from the nipple increased and became mixed with blood. She then came into the hospital.

On admission. A very tense globular swelling, the size of an orange, was present in the centre of the breast. The nipple was flattened out and somewhat retracted; it discharged a yellow glairy fluid, which could be increased on pressing the tumor. The diagnosis of cystic disease of the breast was made.

September 12th. A small canula was introduced into the cyst, and about four ounces of a pale yellow fluid were drawn off. A drainage tube was introduced into the cyst.

16th. The breast discharged a little for a few days, but it ceased on the 19th, and on the 21st she left the hospital well.

Two years later the patient reported herself as still well.

Case IV.—Cyst in breast, which disappeared after tapping.

Eliza T., aged 43, a married, childless woman, came to me February 12th, 1886, with coarse, indurated breasts, and a tense, globular tumor, the size of a walnut, in the left gland, which seemed to be a cyst; there was no discharge from the nipple. For diagnostic purposes this cyst was punctured, and clear serous albuminous fluid drawn off. By April 16th the swelling had gone. Six months later no return had taken place.

Case V.—Duct cyst in breast, which spontaneously suppurated; was opened and cured.

Eliza H., aged 40, a married, childless woman, came under my care in April, 1870, with a tumor in her right breast, which

had been coming for five years and was increasing slowly. She had had serous discharge from the nipple for two years. The axillary glands were not enlarged. At present there is a free discharge of a clear fluid from the nipple, which runs without, but can be increased by pressure. At times the fluid is blood-stained. There is a tumor the size of an orange at the lower part of the gland. An incision was made into the cyst at its lower part, and some ounces of pus were evacuated. A good recovery followed.

It is probable that the spontaneous suppuration of a simple duct cyst of the mamma is rare. I have not seen any other example than the one recorded, in which it was clear that this took place.

In Prep. 4753 of the College of Surgeons there is, however, a cyst of this kind, in which at one spot the inner surface of the cyst appears thinly covered with lymph, demonstrative of an inflammatory action. In this case, as in the one recorded in this paper, the nipple was retracted from traction on its ducts.

The following interesting case has been recorded by Mr. Birkett (Guy's Hosp. Reports, 1872–73), and illustrates the same point.

CASE VI.—Duct cyst of the breast, following a contusion; retracted nipple; twelve years later spontaneous suppuration and recovery.

A delicate single lady, aged 40, consulted Mr. Birkett for a bloody discharge from the nipple, which she had observed for nine or ten years. She attributed it to a blow. The nipple was retracted. When seen a small, fluctuating, painless swelling was present near the nipple, with induration of the gland tissue around it. By compressing the tumor, serum escaped from the nipple. Four years later, when but little change had taken place in the tumor, the discharge from the nipple ceased and the tumor inflamed. Suppuration soon followed, and the abscess burst, when more than ten ounces of pus escaped, and a piece of solid substance as long as the little finger escaped. This was the statement of the patient. The discharge, which continued several days, diminished; the hole, which looked very deep at first, contracted and filled up, and at last became healthy. In fact, adds Mr. Birkett, the disease

was cured by the efforts of nature alone, and has never reappeared in the eighteen years which have since elapsed.

CASE VII.—Cystic tumor of breast; cured by an incision into its cavity, and drainage. (Reported by Mr. Duckworth.)

Louisa N., a healthy-looking married woman, aged 45, was admitted into Lydia ward, Guy's Hospital, on May 1st, 1879, under Mr. Bryant's care. Her paternal grandmother had cancer of the breast. About three months ago she felt some pain in the region of the left breast, but noticed no lump for a month, when she felt one about the size of a walnut on the outer side of the gland. It was freely movable, and when she slept on her right side would slip toward the inner side. It was occasionally the seat of a gnawing or shooting pain. She has had one stillborn child, and never suckled.

On admission. There is a hard, irregular ovoid, lobulated swelling about the size of an egg, on the outer side of the left breast. It is very freely movable, and the skin over it is not infiltrated. The tumor seems, however, to be slightly attached by one end toward the nipple, which is normal.

Operation.—May 6th, under chloroform, an exploratory incision was made about two inches in length on the outer side of the breast into the tumor, which was found to be a cyst. When opened about an ounce of clear fluid escaped. The cavity, which was smooth, was washed with iodine and water, after which a drainage tube was put in and the wound dressed with lint soaked in terebene oil.

8th. No discharge, wound healthy, drainage tube removed. Temp. 97.8°.

12th. Tinct. ferri perchlor., ♏ x.; tinct. calumb., ♏xx.; aq., ℥ i., t. d. s. Temp. normal.

20th. The wound has nearly healed.

24th. Discharged cured. Some months later this patient was well.

CASE VIII.—Cyst in breast, simulating carcinoma; exploratory incision; plugging of cyst; recovery.

Martha J., aged 50, a married woman, came under my care on January 9th, 1886, with a tumor the size of an orange, occupying the centre and axillary half of the left breast, retracted nipple, and healthy skin over the tumor. No axillary glands found enlarged. She first noticed the lump five years previously, which had steadily and almost painlessly increased.

It was the seat of an occasional shooting pain. The tumor and breast were one; it was hard and inelastic; no nipple discharge. An exploratory puncture or incision was determined upon. On January 19th, when the woman was under the influence of an anæsthetic, fluctuation was detected; an incision was then made into the tumor in a line radiating from the nipple, and a cyst opened; three ounces of a dark-colored fluid, containing cholesterin, was evacuated. No intracystic growth was found, and the lining membrane of the cyst was smooth. The cavity exposed was then plugged with iodoform gauze dipped in terebene oil to excite suppuration, and the case did well.

CASE IX.—Cyst in breast treated by incision; doubtful thickening remaining; well. (Reported by Mr. Duckworth.)

Harriet S., a single woman, aged 35, was admitted into Lydia ward on May 21st, 1879, under Mr. Bryant's care. Six years ago she had an abscess in her neck. About four months ago the patient experienced, when at work, a dragging pain in her chest and shoulder, and found upon examination a small hard lump, about twice the size of a pea, in her right breast. It was freely movable, and occasionally gave pain at the back of her shoulder. She has no recollection of having received an injury.

On admission. To the left of the nipple of the right breast there is a hard, irregular, lobulated lump the size of a small orange, with a base occupying about the area of a half-crown. It is freely movable, and does not infiltrate the nipple or breast. The axillary glands are slightly enlarged.

May 21st. She is menstruating; her menses have been irregular for some time. They generally last ten days.

27th. Under chloroform, an incision was made over the tumor, radiating from the nipple, and about two and a half inches in length. Having cut into the tumor, about an ounce of brownish fluid escaped; the walls of the cyst were smooth. The parts were washed out with iodine and water and a drainage tube introduced; the edges were then partially brought together with four sutures.

28th. Temp. 98°, pulse 88.

29th. Temp. 98.2°. Two sutures taken out; wound looks healthy.

June 1st. Temp. 98.9°, pulse 96. Wound closed well, nar-

row line of granulations on surface. A lump about size of a hazelnut felt below the incision.

24th. Patient left the hospital cured.

CASE X.—Cyst in right breast; treated by a free incision; no intracystic disease; patient well four years later. (Reported by Mr. Gowan.)

Mary S. R., aged 40, was admitted on October 15th, 1883, into Lydia ward under Mr. Bryant's care. Patient is a tall, well-formed, and well-nourished woman. She is a widow. Has never borne a child, and has never been injured in the breast. Two months ago she first noticed a lump in her right breast about the size of a pigeon's egg, and a little to the right of the nipple. It has grown somewhat rapidly since.

On admission. The right breast does not appear much larger than the left. Both are well developed and firm. The right nipple is slightly tinged with brown, but not retracted, nor is the skin dimpled. A tumor, about the size of a large orange, occupies the upper and outer quadrant of the right breast; it is globular and smooth, and indistinctly fluctuates. Neither the skin nor adjacent muscles are implicated apparently.

October 16th. Under chloroform the tumor was punctured with a scalpel, when about one and a half ounces of blood-stained serum gushed out. The incision was enlarged, and the cyst walls were found to be free from growth, smooth and thin. The wound was plugged with iodoform gauze, and dressed with gauze and flannel bandages; the arm was fastened to the side.

November 19th. Left hospital; there is still an open granulating wound 1½ inches long by ¾ inch. Patient's general health is good.

Three years later this patient was quite well.

CASE XI.—Deeply placed cyst in sternal lobe of right breast, simulating adenoma in gland; exploratory incision; plug. (Reported by Mr. C. Lloyd Jones.)

Margaret V., a domestic servant, aged 37, was admitted into Lydia ward on February 23d, 1877, under Mr. Bryant's care.

She stated that her father died at seventy years of age of some internal tumor, and her mother at thirty of hepatic disease. Her brother and sisters were all healthy. She was

unmarried, and always enjoyed good health. She fancied that she had become a little thinner during the past winter, and lately her menstrual intervals had become three weeks instead of a month. Three weeks before admission she happened to place her hand on her right breast, when she noticed a lump there. She felt no pain in it, and it had not increased in size since it was first noticed.

When admitted, the hand pressed flat against the breast at once detected, at the upper part of the right breast, a tumor which was nearly circular in shape, about two and a half inches in diameter, and flattened. It felt hard, and its surface was distinctly lobulated. The tumor was movable with the breast, the skin was nowhere puckered nor adherent, and there was no pain on manipulation. The nipple was normal. No enlarged glands in axilla or elsewhere.

The patient could assign no cause for the appearance of the tumor, and she stated that she was, as she appeared to be, in very good health.

March 9th. Under an anæsthetic an incision was made into the tumor, when blood-stained serum escaped; the lining membrane of the cyst which occupied the posterior part of the lobe was smooth; the cyst was plugged.

15th. Wound nearly well. The patient had not had one bad symptom or any rise of temperature.

Remarks.—In this case the true diagnosis was not at first made, nor was the true nature of the case suspected; the tumor had none of the appearances of a cystic growth, since it was quite inelastic, and its surface was nodular and hard.

The cause of this error in diagnosis is to be explained by the position of the cyst, which was covered in by a gland of quite three-quarters of an inch in thickness, the gland giving the nodular outline and yielding the firm feel.

At one time the question of infiltrating carcinoma was considered, on account of the growth so closely involving the gland and appearing as an infiltration, but this was dismissed in favor of the adenoid view, the outline of the tumor appearing more of the latter disease.

Had this case been punctured for diagnostic purposes its true nature would have been discovered.

Case XII. Cyst of mamma mistaken for carcinoma, and excised; cure. (Reported by Mr. C. E. Perry.)

Anne F., a married woman, without children, aged 47, was admitted into Lydia ward, under Mr. Bryant's care, on January 14th, 1875, with a hard round swelling, about the size of a mall tennis ball, in the upper and outer part of her left breast; it was movable with the breast and without pain except on pressure. It was regarded as a carcinoma. It appeared that an aunt on her mother's side had died of cancer in the breast. She herself had had good health until about five months before admission, when she felt a swelling about the size of a small egg in her left breast: it remained about the same, without pain, for three months, when, pain coming on, she sought advice, and had some embrocation, which she left off after a few days, as it brought out a rash. She then fomented it, and nothing else was done up to the date of her admission.

January 26th. Chloroform having been given, the breast and tumor were removed by two elliptical incisions. On cutting into the tumor it was found to be a simple cyst full of fluid.

The patient did well after the operation, and left the hospital convalescent.

The preparation is in the Guy's museum, No. 2290[80].

Case XIII.—Sero-cystic disease of right breast; removal of lobe: inflammation of the remainder, and recovery.

Mrs. S., a childless, married woman, aged 50, was brought to me by Dr. Wallace, of Hackney, March 15th, 1875, with a tumor in the axillary lobe of her right breast, which had been steadily increasing for three months. The tumor was hard and lobulated, and I supposed the growth to be simple, and advised its excision.

March 21st. On excising the tumor I found it to be made up of cysts, and in making the section of the gland the whole breast was found to be full of small cysts (involution cysts), many of which I punctured. I could not remove the whole gland, as I had undertaken to remove the tumor alone.

During convalescence the remainder of the gland inflamed and indurated, putting on the clinical features of acute cancer. The induration, however, subsequently entirely subsided and the patient recovered.

In 1881 she was quite well.

The tumor on removal was made up of cysts of various sizes, the largest being about the size of a walnut. The cysts

contained fluid of different kinds. In some it was clear, in others blood-stained, whilst in a few it was mucoid and greenish. There were no intracystic growths. Some of the ducts were open, and through these bristles could be passed.

The gland was clearly undergoing cystic degenerative changes, and in the lobe removed these changes had gone on rapidly.

CASE XIV.—Sero-cystic disease of breast following injury; excision of gland; patient well six years later.

Miss D., aged 34, patient of Dr. S. Tayleur Gwynne, of Whitchurch, Salop.

In June, 1864, she had a blow upon her left breast, which was followed by pain for two months, and then the appearance of a swelling.

In January, 1865, when I saw her, the swelling clearly occupied the sternal half of the gland, and was tense, giving the idea of a cyst. General health good. By December of the same year the tumor had increased, and had become lobulated; it, moreover, was more painful. Nipple and lymphatic glands normal.

December 29th. Breast removed and found to be a pure cystic disease of the gland. Cysts contained brown thin fluid, some clear serum. No intracystic growths.

Rapid recovery ensued, and six years later the patient was well.

CASE XV.—Sero-cystic disease of breast; excision of breast; patient well six years subsequently.

Mrs. R., aged 40, the mother of seven children, was brought to me by Dr. Wilton, of Sutton. Her left breast has no nipple; it had been destroyed by old ulceration. The right breast is the seat of cystic disease, which involved the whole gland, and had been going on for months. The gland was very large, with an irregular outline, and clearly contained cysts of all sizes. The nipple and skin over the breast were normal.

January 29th, 1881. Breast removed, and the operation was followed by a good recovery. The gland was full of cysts of all sizes, which contained a great variety of fluids. No intracystic growths could be found.

January, 1882. Pregnant. Natural delivery. Left breast strapped. No nursing trouble.

1887. This patient is now well.

Case XVI.—Sero-cystic disease of breast; excision of breast; patient well eleven years later.

Mrs. S., aged 39, the mother of three children, all of which she had nursed without trouble, the youngest being fifteen years of age, was brought to me by Mr. Joseph Burton, of Blackheath, in 1876, with an irregular nodular tumor in her left breast, which had been coming on several months. It was apparently cystic, and involved the whole gland. The skin over the gland was normal. Her mother had had cancer of her breast, and the sister some internal tumor.

February 16th, 1876. Breast removed. On section a large cyst without intracystic growth, containing fluid as dark as ink, was found, with many smaller cysts containing fluid of different characters. In fact, the whole breast was full of cysts of different sizes. A good recovery ensued; and in 1887, eleven years later, the patient was well.

Group III.—Cystic Tumors of the Breast of whatever kind in which Papillomatous, Adenomatous, Sarcomatous, or Carcinomatous Intracystic Growths are Present.

If, clinically, simple cystic tumors of the breast are fairly common, pathologically they must be pronounced to be comparatively rare, for it is, I think, indisputable that in the majority of cystic tumors of the breast, of whatever character, of duct cysts, gland cysts, or connective-tissue cysts, some solid element can usually be found proliferating from their lining walls, either in the shape of a small sessile or pedunculated outgrowth, or of a solid tumor composed of glandular, epithelial, or connective-tissue elements; the nature of the growth being determined by the seat and persistency of the local source of irritation which originated the formation of the cyst. When the cyst is single the growth will of necessity involve it alone. When multiple, some of the cysts may be simple or non-proliferating, while others are proliferating, the association of the two kinds in the same gland being not uncommon. The surgeon consequently meets with cystic tumors of the breast, in which in one case papillomatous growths are present; the papilloma being a simple outgrowth of the cyst

wall, in the same way as the same growth may spring from the nipple or other structure; while in another case the cyst may have an adenoid growth hanging or springing from its walls, the growth appearing either as a pedunculated intracystic growth washed with the cyst contents, or the cyst may be filled with sarcomatous or adenoid tissue either of a loose or more solid structure; the tumor in the latter case, when the cyst is full, losing much of its cystic character and approaching the more solid kind, whilst the intermediate conditions between these two extremes suggest and give support to the view which some pathologists entertain, that these solid adeno-sarcomatous or fibromatous tumors as a rule originate in cysts, and only differ in the degree in which the cyst cavity is filled.

In many cases, doubtless, what appears to be an intracystic growth is nothing more than a growth originating in the connective or glandular structure outside the cyst, but projecting into it, and having its surface bathed with fluid, the fluid being either the secretion of the cyst wall or an exudation from the growth itself into the cyst cavity. The same remarks are also applicable to sarcomatous and carcinomatous tumors. Without doubt a large number of tumors of the breast begin as cystic, and pass on to become sarcomatous and carcinomatous; the connective-tissue element in the former case, and the epithelial element in the latter, so increasing and filling what was at one time simply a cyst or cysts, as clinically to form what is now known as a cystic sarcomatous, cystic adenomatous, or cystic carcinomatous tumor. These varieties in the cystic disease maintain the same clinical features as characterize the more solid kinds; the symptoms of the solid and the cystic being the same in each, with the addition in the latter of the cyst element. The diagnosis of a cystic adenoma, cystic adeno-fibroma, sarcoma, or carcinoma is consequently to be determined by the same points as are known to characterize a solid adeno-fibroma, adenoma, adeno-sarcoma, or carcinoma, with the addition of such clinical symptoms as are clearly referable to the existence of cysts.

The following cases will best illustrate the clinical features of the disease.

Case XVII.—Cystic (duct) adenoma of breast; excision of lobe.

Mrs. D., aged 45, the mother of four children, the youngest of whom was eight, and who had only nursed her first child, consulted me in April, 1876, for a tumor in her right breast, which had been discovered six weeks, and had steadily increased. I took it to be a cyst. The swelling was central and very cystic to the feel. The nipple projected more on the right than the left side, and discharged blood-stained serum. The skin over the gland was healthy and the lymph glands were natural. I advised puncture or incision, and excision if the cyst was found to contain growth. The late Mr. Jardine Murray, of Brighton; operated in May, 1876, and found a pedunculated intracystic growth, which, on examination, I proved to be an adenoma. He then excised the affected lobe, and a good result followed.

Five years later this lady was well.

Case XVIII.—Case of cystic adeno-fibroma of the breast, in a woman, aged 71; excision of gland; cure.

Catherine K., aged 71, a healthy-looking woman, the mother of three children, was admitted into Guy's Hospital, under the care of Mr. Bryant, on August 7th, 1865. She had always enjoyed good health, and had been able to suckle her children. About last Christmas, some time before admission, she accidentally discovered a lump, the size of an egg, in the outer side of her right breast; it was painless, and grew very slowly for three months, when it suddenly began to increase rapidly in size, and to cause pain. She applied to Mr. Bryant for relief, and remained under his care till she was admitted. On her admission the right breast presented a large tumor, the size of a cocoanut, closely connected with, if not in, the breast. It was irregular in its outline, and evidently in parts made up of cysts, for, in its projecting portions, distinct fluctuation was clearly felt. There was, however, much solid matter. The tumor was quite movable, and the skin over it was only stretched; the axillary glands were also healthy; the nipple was natural.

Nothing but excision promising to be of any use, the operation was performed on August 30th, and a rapid recovery took place, the old woman leaving the hospital in one month perfectly well.

On examining the tumor it was found to be made up of a firm solid material, which contained several large cysts. These cysts held a blood-stained glairy fluid, and in parts the solid growth seemed to threaten to degenerate and break up.

The tumor measured seven inches by six; it was very firm in its consistence, and to the eye appeared of a sarcomatous nature; it was tough, and was with difficulty broken down; in parts, however, it had more the aspect of the looser kind of adenoid tumors.

By the microscope, the opinion formed by the naked-eye examination was confirmed, for the structure generally was an admirable specimen of the more fibrous kind of adenoid tumor; tubes were here and there visible, and also well-developed cell structures, as a drawing by Dr. Moxon indicates.[37]

As an example of an adeno-fibroma in an old woman, the case must be regarded with great interest.

CASE XIX.— Cystic sarcomatous disease of the breast of fifty years' growth in a woman seventy-three years of age.

E. C., a healthy-looking old woman, 73 years of age, came under my care on October 5th, 1862, with an enormous tumor, the circumference of a soup plate, in her left breast. She was a married woman, the mother of one child, who was fifty years old. During her pregnancy with that child, she observed a small lump in her left breast, which was movable. This gradually increased in size, but in such a painless way, that she kept her trouble to herself; about three months before she came to me the tumor burst and discharged much blood-stained serous fluid; it was on this account alone that she sought advice. When I saw her a large bossy tumor occupied the position of the left breast; it was fluctuating in parts, and the skin over it was healthy, though much thinned. The nipple was flattened out over it. At one part the skin had ruptured, and the rent appeared as a fissure, with a thin but healthy margin, and through this opening sprouted a large fungating growth. The absorbent glands were natural, and the patient's health was good. No operation was sanctioned.

CASE XX.—Cystic (duct) adenoma of breast, excision of gland. Patient well six years later.

Mrs. T., aged 54, the mother of several children, all of whom she had nursed without trouble, consulted me in October, 1880, for a tumor of her breast which she had noticed for

about a year. The appearance of the tumor had been preceded for months by the discharge of a serous fluid from the nipple. The tumor was about the size of a tennis ball, hard and globular; pressure upon it caused blood-stained serum to flow from the nipple. The skin over the swelling was natural, and the nipple was not changed. The diagnosis of a duct cyst was made, and an incision advised into the tumor with the view to an excision should an intracystic growth be found. This was performed on October 23d, 1880, and the breast removed, as a pedunculated intracystic growth was found in the cyst (Fig. 8). A good recovery ensued, and the patient was well six years later.

Fig. 8. — Pendulous Intracystic Adenoid Growth. Case 20.

The growth was examined by Mr. Symonds, who reports:

The growth was one and a quarter inches in diameter, and was attached by a small pedicle to the smooth wall of the cyst in which it was enveloped. It had a deep purple-red color, was soft, and separated easily from its attachment. Round the cyst and in its wall were many dilated ducts, some of large size, but no direct communication could be traced. The cyst appeared to be produced by dilatation of a duct. Nowhere in the breast was there any other growth.

Fig. 9.—Microscopical Appearance of Breast Adenoma. Case 20.

The tumor had a lobulated appearance, as exhibited in Fig. 8, and its pedicle was small; microscopically the growth showed all the characters of a pure adenoma as seen in drawing (Fig. 9). It is composed of large spaces of various shapes, lined by closely set cells. These have large nuclei and one or more nucleoli. The supporting framework is a very delicate fibrous tissue, containing cells of various shapes,

besides blood-vessels. From the walls of many acini conical projections grow, which often blend with the opposite wall.

The tumor therefore appears to be a pure adenoma growing from the wall of a duct. The small amount of fibrous tissue, and the normal characters of the breast tissue immediately round the cyst, negative the view that it is a fibroma budding into a dilated duct. This growth is identical with that called now a "duct papilloma."

CASE XXI.—Cystic duct tumor with pedunculated adenocele of breast; excision; patient well three years later. (Reported by Mr. W. T. Crew.)

Susannah W., a single woman, aged 43, was admitted under Mr. Bryant's care, into Lydia ward, on February 2d, 1876, with a globular tumor involving the whole of her right mamma, and extending into the axilla, on the inner side of which there were little hard nodules like peas. The tumor within the breast gland was freely movable under the skin and over the pectoral muscles; the veins were distended over the tumor. Fluctuation was very distinct over the greater part of the swelling; there was no discharge from the nipple, and the lymphatic glands were unaffected.

In 1872 she first noticed an exudation from her nipple like glycerin; soon after, a lump the size of a walnut appeared in her breast without pain, and the swelling increased. The breast would sometimes feel tense, but became relieved as soon as the discharge took place. For six weeks there had been no discharge.

February 3d. The patient having a little cough the operation was deferred until the 8th, when chloroform having been administered, an elliptical incision was made, and the whole tumor, with nipple and a portion of the skin, were dissected out and removed.

The tumor was mainly composed of a cyst which contained about half a pint of mucoid fluid, and was lined by a thin, delicate, white membrane; attached to its walls were several lobulated pedunculated tumors as seen in woodcut (Fig. 10). The growth examined showed a well-marked papillomatous structure. The processes are covered by long columnar cells, and often divide. Circular or elongated apertures lined by the same cells are also numerous. There are also small cysts with definite fibrous walls and colloid contents.

The growth closely resembles that in Mrs. T.'s case, No. XX., and suggests that the large cyst in this instance is also derived from a duct. The small cysts in this growth have been formed, I suppose, by the fusion of the processes in the manner described by Wilson Fox. Several small adeno-fibromatous tumors were also found on making sections of the gland in other parts of the breast. The arteries were twisted, wire sutures inserted, pressure was exerted by pads of lint, and the whole wound drawn together by strips of strapping.

FIG. 10.—Cystic Duct Tumor with Pedunculated Intracystic Growths. Case 21.

21st. The wound has healed by first intention.

Three years later the patient was well.

CASE XXII.—Cystic duct adenoma· excision of tumor; cure.

Harriet W., aged 47, the mother of thirteen children, youngest six years old, all of whom she had suckled, was brought to me on January 14th, 1867, with a globular tumor, apparently cystic, in the upper part of her left breast, which she had observed six months. At first she had a clear discharge from the nipple, but she had not had any lately. The skin over the tumor is apparently bound to the growth. Axillary glands sound.

September 15th. Serous discharge from nipple very free; increased by pressure. Tumor large.

March, 1868. Tumor removed and found to be composed of a cyst, with intracystic pedunculated growth, which was pronounced by Dr. Moxon, after microscopical examination, to be adenoid.

CASE XXIII.—Duct cyst of the breast, following a contusion; intracystic fibro-cellular growths; rupture of cyst seven years later; removal of breast; recovery; patient well twelve years later.

In 1860 Mr. Birkett saw a lady, aged 45, who for seven years had had some tumor in her right breast. In 1853 she received a blow in the part, which was followed by a flow of

blood from the nipple. Two months later an abscess formed, and was opened, a cupful of matter escaping. The abscess healed, but some hardness remained, and occasionally a bloody fluid oozed from the nipple. At times half a pint would flow daily.

Subsequently a soft tumor formed and grew, and the nipple retracted; and two weeks before consulting Mr. Birkett the skin over the tumor ulcerated, and a quantity of blood and fluid escaped. When seen, a soft, vascular, flocculent growth, very like everted mucous membrane, projected slightly from an opening in the integument, with which, however, it was not connected, and from which serous discharge flowed. There was no pain. The nipple, which had been inverted, was now everted. The axillary lymphatic glands were tender, but not infiltrated. Her general health was good. The whole breast was removed, and a rapid recovery followed. The patient twelve years later was well.

A section through the disease exposed a cyst, with firm fibrous walls, imbedded in adipose tissue. Three pedunculated masses of soft, vascular new-growth were hanging from the cyst wall. From the nipple a bristle was passable along a duct into the cyst. The intracystic growth was composed of fibre tissue, nucleated bodies of variable shapes, and a reticular stroma with an arrangement like papillæ or villi. The true gland tissue was nowhere visible.

Case XXIV.—Cystic duct sarcoma of the breast which never secreted milk.

Mrs. G., aged 45, the mother of one child, aged 17, consulted me in February, 1881. She had suckled with her right breast, but not with her left, because she had no milk in it, and the nipple was retracted. For six years she had had a discharge of a clear fluid from the retracted nipple of the left breast, and which at the catamenial periods was increased; the fluid at times was like "treacle water." Three months ago this flow stopped and a lump appeared.

A tumor the size of a walnut exists in the centre of the breast beneath the nipple. There is no discharge from the nipple. I advised incision and excision if necessary. Dr. Godfrey, of Balham, subsequently tapped the cyst and discovered a growth, the excision of which was advised, but not acceded to.

Case XXV.—Cystic sarcoma of the breast fourteen years; removed; well seven years later.

Mrs. B., aged 42, of Bottesford, Nottingham, consulted me in 1877 for a tumor in her left breast of fourteen years' duration. She was the mother of four children, the youngest being four years old, all of whom she had suckled. At the birth of the last child, four years ago, the tumor was no larger than an egg. For the last six months it had grown rapidly, and is now as large as a fist. It is clearly cystic from its nodular shape and fluctuating feel. There is no discharge from the nipple. No lymphatic glands are enlarged. Excision was advised and performed, and a good recovery followed. In 1884, seven years after the operation, the patient was well. Her maternal grandmother had died from cancer of the tongue, and her paternal grandmother from cancer of the breast.

Case XXVI.—Cystic sarcoma of the breast; retracted nipple; excision; well eight years later.

Mrs. S., aged 50, the mother of nine children, one only of whom she suckled without difficulty, consulted me in March, 1876, for a tumor in her breast, which had been steadily increasing for two years. Eight of her children had died of phthisis at ages varying from fifteen to twenty-seven. When seen the tumor was the size of a fist, smooth, slightly lobulated, globular, and elastic; it appeared to be cystic. The nipple did not discharge, but was retracted. The axillary glands were free.

April, 1876. It was excised by Dr. Sams, of Blackheath, who sent me the specimen.

April 11th, 1876. Dr. Goodhart reported: "The tumor is spindle-cell sarcoma or recurrent fibroid, as I expected from its lobulated appearance and manner of growth. They are not at all uncommon in the breast, and are often called adenoid growths from their very similar naked-eye appearance. It will probably return in the cicatrix, though glands are less likely to be involved in the axilla."

In 1886 this lady was still well.

Case XXVII.—Cystic sarcoma of breast; rupture of cyst; hemorrhage; excision; recovery.

Mrs. S., aged 71, consulted me in January, 1873, for a tumor of the breast of twelve years' growth. It was then the

size of a child's head. One cyst had ruptured, and an intracystic growth sprouted from its centre which bled freely. On this account an operation was advised, and performed on February 26th, 1873. A good recovery ensued. The disease was on examination found to be one of cystic disease, with intracystic sarcomatous spindle-celled growths. This lady died, more than three years after the operation, in September, 1876, from acute bronchitis.

CASE XXVIII.—Cystic duct adeno-sarcoma of the breast of several pounds weight, as indicated by free discharge from the nipple, into which hemorrhage had taken place; excision; recovery.

Mary A. W., a healthy-looking single woman, aged 20, came under my care March 26th, 1861, with a tumor in her right breast which had been growing for three years and a half. It had commenced as a swelling the size of an egg, which was situated in the centre of her breast, and had steadily increased without pain. When coming under observation the tumor was of the size of an orange, globular and tense. I diagnosed it to be of cystic origin. She disappeared from view for eighteen months, and when she reappeared the tumor measured fourteen inches in diameter and twenty-two inches in circumference. It was globular, with the nipple in the centre; quite movable with the breast, and uniformly elastic; fluctuation was readily to be detected in it. The skin was much distended over the tumor, and on its outer side it was red and inflamed from distention. The breast gland could not be separated from the tumor.

The tumor during the interval mentioned above had grown slowly up to six weeks, when its increase became rapid. For three weeks there had been a free discharge of a bloody fluid from the nipple, which could be readily squeezed out by pressure upon the tumor.

On March 15th, I tapped the tumor, and let out a quantity of bloody serum and broken-down blood; to allow of its more ready evacuation the opening was enlarged, when the finger, without force, easily broke up a large portion of the growth. Two and a half pounds of this material were thus taken away. The largest portion of the tumor was, however, of a more solid nature, which necessitated the removal of the whole gland. This was done, and a good recovery followed.

A section of the tumor through its centre and the nipple showed a fine example of cystic sarcoma of the breast. At its lower part were many beautiful examples of intracystic adeno-sarcomatous growths, which turned out of their cyst walls. About the centre of the tumor were smaller growths, infiltrated with blood, and breaking down; and in the upper part there was little else than extravasated blood and clot. Microscopically, all the elements of sarcomatous tumors were present, spindle-cells being abundant; there were, too, some glandular elements such as are found in adenoma.

CASE XXIX.—Cystic sarcoma of the breast; rupture of cyst; operation refused.

Clara W., aged 43, the mother of three children, the youngest being fourteen years old, consulted me on March 7th, 1867, for a tumor the size of an orange in her left breast, which had been growing thirteen months. It was globular, semi-elastic, and nodular. The skin, nipple, and axillary glands were sound.

April 7th. Tumor much larger; its bossy surface is lost, and the growth seems to be one large cyst. Cyst tapped, and about one ounce of blood-stained fluid drawn off.

June 2d. Tumor size of cocoanut.

July 8th. Tumor burst and discharged fluid largely mixed with blood. Operation refused. Intracystic growths visible; later on some of the growths projected through the rupture in the cyst wall.

July 16th, 1868. Patient sinking from asthenia and bleeding from the growth.

CASE XXX.—Cystic sarcoma of breast; rupture of cyst; operation rejected.

Mrs. R., aged 63, married at age of twenty-one and had five children, the youngest aged thirty. Nipple in left breast always retracted. Thirty years ago, independently of nursing, she had a tumor the size of a fist in her left breast, which disappeared after one year. She remained well for twenty-eight years, up to one year ago, when the swelling reappeared in the same breast, and this has gradually grown.

At present (July 9th, 1873) a tumor the size of an egg exists in the upper part of the breast, which seems to be a cyst; this is adherent to the skin. Excision of the tumor was advised but not accepted.

January 19th, 1874. The cyst, which has much increased in size, has ruptured and discharged its contents, a sarcomatous growth protruding from the skin opening. No operation was sanctioned.

CASE XXXI.—Cystic sarcoma of breast; suppuration of a cyst followed by rupture of cyst; no operation.

Mrs. C., aged 43, of Hull, the mother of five children, her youngest child being now fourteen years of age. After giving up nursing there was discharge from her nipple of a clear greenish or blood-stained fluid. Six months ago this discharge ceased, and the breast enlarged, inflamed, and suppurated. It was opened at that time by Mr. W. H. Rudd (April, 1883), and the abscess healed, leaving a lump. This increased in spite of treatment, and is now the size of a large egg. It appears to be (February, 1884) cystic. Incision into the cyst was advised, and excision of the lobe advised if growth was found. Nothing was, however, done, but the cyst burst and discharged bloody fluid, and discharge has been going on up to the present (October 12th, 1884).

CASE XXXII.—Cystic sarcoma.

Mrs. S., aged 70, has had three children, which she never suckled. In 1875 she consulted me for a tumor in her right breast, which she had had four years; when seen by me it was the size of a cocoanut, clearly cystic, and nodular. No lymphatic glands were enlarged. Skin normal. Operation not advised on account of age.

CASE XXXIII.—Cystic fibroma of right breast, with cystic degeneration of the gland; excision of tumor; cured. (Reported by Mr. Metzgar.)

Rebecca B., aged 40, was admitted into Lydia ward on June 21st, 1884, under Mr. Bryant's care. Patient's father and two brothers died of phthisis, and she frequently suffers from bronchitis and neuralgia. She is married, and has one son alive and healthy. Six weeks ago she noticed an uncomfortable swelling in her right breast, which appeared as a prominent tumor in the upper half of the gland. This tumor has not increased much since then, but it has seemingly got softer.

On admission. The tumor is hard and nodulated, firmly imbedded in the gland, but freely movable with it upon the pectoral muscles. The skin over it is normal. The axillary glands are not enlarged. Nipple natural. Urine normal.

June 24th. Under chloroform an oblique exploratory incision was made into the tumor. The tumor, when incised, appeared granular and fibrous, a fibroma apparently growing from or into a cyst; the breast itself had undergone cystic degeneration. The tumor was then freely separated from the surrounding breast tissue and removed. In so doing black cysts were seen spread over it. The vessels having been twisted, and capillary hemorrhage stopped by hot iodine sponges, three silk sutures were put in, and one and a half inches of drainage tube were inserted into the upper and left end of the incision, the lower or right half being well padded with lint and a sponge. The arm was strapped to the side.

June 25th. Drainage tube removed.

30th. Stitches removed. Lips of wound drawn together with waterproof strapping.

July 11th. There has been good primary union. There is very little discharge. A plug of terebene lint into the lower and right end of the wound.

26th. Went out, to come up from time to time to be seen. This patient was subsequently quite well.

The tumor when removed proved to be a fibroma growing from the walls of a cyst. The gland itself was full of small cysts, the result of degeneration.

The temperature only on three occasions after the operation reached 100°.

CASE XXXIV.—Recurrent mammary cystic sarcoma; excision; well. (Reported by Mr. H. H. Wright.)

Eliza M., aged 36, was admitted into Lydia ward on July 14th, 1880, under Mr. Bryant's care. Patient is a married woman, and the mother of eight children. Three years ago she was operated upon for tumor of the left breast; the tumor was removed, but the breast was left. She has since been able to suckle a child at the same breast. A year ago she noticed a small lump above the nipple, which has steadily increased. On admission there was a large lobulated tumor involving the whole of the left breast, but divided into two chief parts. One of these occupies the central and upper part of the gland; the other, which is smaller, is placed on the axillary side. The whole tumor is above the level of the old cicatrix. It is freely movable, partly hard and partly elastic

to the touch. One point above and to the inner side of the nipple is inflamed and painful.

July 20th. Under an anæsthetic the whole breast was excised.

The patient suffered a little from conjunctivitis after the operation, but otherwise did well, and on August 16th went out, the wound having healed.

Description of Tumor.—The tumor was everywhere encapsuled. It was composed of many lobules, separated from one another by fibrous septa, and each inclosed in a capsule. Some of them grew into thin-walled cysts containing little or no fluid, their walls being in contact. The growths in these cysts were in some cases lobulated finely on the surface. In a few, they resembled in color and smoothness a mucous nasal polypus, but were in consistence a little firmer. The majority of the lobules showed on section a finely lobulated appearance, the outlines of the little lobules being crenulated, and some having a distinct cavity in the centre. No communication could be traced between the various cysts, nor could any be traced directly to the nipple. Some parts of the growth were hard, firm, and fibrous. There were no blood cysts, nor any of the translucent-looking material so common in a sarcoma. In some of the nodules (felt elastic during life) there were many elongated slit-like spaces with smooth walls, the surrounding material being acinous.

Histologically the tumor was composed of spindle cells and gland elements (adeno-sarcoma).

CASE XXXV.—Cystic (duct) sarcoma of right breast; early symptom hemorrhage from nipple; amputation. (Reported by Mr. Phillips.)

Eliza A., aged 45, a governess, was admitted into Lydia ward on January 8th, 1884, under Mr. Bryant's care. Patient was delicate, but never had any particular disease. Breasts have been always tender, but no history of injury. Menstrual periods regular.

In January, 1883, one year before admission, patient first noticed a pale brownish discharge from the right nipple. It lasted three months, and was increased during her menstrual periods. In March she noticed a lump, the size of a small marble, on the upper and inner part of her right breast. This increased visibly during her menstrual periods. About two

months ago it began to grow, and since then her menses have been irregular.

On admission. Patient is a florid-looking woman, and apparently healthy. The upper and inner aspect of the right breast is occupied by a "firm but not hard" lump, measuring $2\frac{1}{4} \times 1\frac{1}{2}$ inches, and with the longest axis vertical. The lump is painful. There is no fluctuation. The skin is not very movable upon the growth. A hard cord can be felt running down from the growth to the nipple. During pressure upon the tumor a few drops of serous fluid mixed with blood came from the nipple. Under the microscope this fluid was found to consist of blood-corpuscles forming rouleaux. A small gland the size of a nut exists in the axilla.

The breast was removed, and found after removal to have been the subject of cystic degeneration of the gland. Into some of the cysts sarcomatous growth of the spindle-celled variety existed. Plate IV., Fig. 9, was taken from this case.

19th. There was primary union all down the wound except at its lower part. The uppermost stitches were taken out.

26th. Drainage tube taken out.

February 1st. There is perfect union of wound.

9th. Discharged well.

The temperature ran a normal course throughout.

CASE XXXVI.—Cystic adeno-sarcoma of breast; excision.

Miss C., aged 46, consulted me on July 10th, 1885, for an affection of her left breast, which had been coming on for about six months, and was accompanied with some pain. The whole gland seemed to be indurated and enlarged, and to the hand felt coarse and nodulated; below the nipple a hard mass was felt. The nipple was natural, and discharged a blood-stained fluid, more particularly after manipulation. The skin over the breast was natural, and the lymphatic glands were not enlarged.

On July 11th the breast was excised, and a good recovery ensued.

To the eye the breast was clearly undergoing cystic degeneration, the whole gland being full of small cysts. In one lobe these cysts had much increased, and one of them contained an intracystic growth. The cysts had evidently a connection with the ducts, since during life there was a nipple

discharge, and after the removal of the gland fluid could be squeezed out of the nipple.

Mr. Symond's report on the case is appended.

Report of Case by Mr. Symonds.—The breast was found to contain a large cyst in the tissue just beneath the nipple, measuring one inch across. Projecting into one end of the cyst was a rounded solid growth, with an uneven papillomatous-looking surface. This extends beyond the limits of the fluid-containing portion of the cyst as a solid cylinder, round which the cyst wall is closely fitted, so that in a transverse section the appearance is much that of a large vein filled with a growth. The section has a whitish-gray color. No other cyst of any magnitude was seen, but there were many small ones. The rest of the breast looked fairly healthy. The tissue was hard, but no definite tumor was visible.

Microscopic Examination.—The solid growth is composed of irregular glandular acini, lined by short columnar cells, with a deep layer of a less regular form. In many places the cells are heaped up, and then are smaller. The stroma is composed of fine fibrous tissue, and contains here and there a cavernous arrangement of vascular tissue. It is very delicate in parts, and forms but a small portion of the whole; in other places, however, especially where the growth is connected with the wall and outlying breast tissue, there is much solid material. This contains much fibre tissue, spindle, and a few myeloid cells, and closely resembles a sarcoma. This solid growth does not form a separate tumor in the breast, for at no great distance from the cyst wall the ordinary mammary tissue is reached. Such a structure as that described might be looked upon as the starting point of the growth, but it forms so small a part of the whole, and reaches so short a distance into the breast tissue proper, that the view seems not so reasonable as the one stated below. The cyst wall is lined with the same short columnar cells.

There are other cysts visible under the microscope varying from a size slightly larger than a normal acinus to $\frac{1}{8}$th inch across. The smallest are evidently dilated acini and ducts. These are lined with rounded or columnar cells, according to their source of origin. The larger ones, of which two or three were found, contain, besides the granules, large round or oval cells with nuclei, and these cysts are lined by peculiar large

cells. They exhibit an intracellular and intranuclear network, have a more or less columnar shape altered by pressure, and large prominent nuclei. They are set directly upon a wall of close fibrous tissue containing elongated nuclei. In places these cells are heaped up and proliferating. They are undoubtedly the progenitors of the large granular cells found in the cysts. Sometimes cells of this character are found filling spaces in the glandular formations, and showing in great contrast to the dark, short, columnar cells, for they are themselves pale, except for the nucleus and granular appearance. In these smaller cysts there are also found glandular growths, connected with the wall. Where attached to the wall there is no solid growth in the neighboring breast tissue.

So far as the description has been carried, it will appear that there is no solid growth except that found in the cysts.

Examining other parts of the breast, it is found that everywhere some change is going on, that there is a widespread activity manifesting itself throughout the entire organ, culminating in the formation of cysts and glandular growths. Again, it must be stated that nowhere is any highly nucleated tissue to be found except on the margin of the large cyst above referred to. The fibre tissue is dense, and contains few nuclei, and everywhere fat is found, so that in all the illustrations adipose tissue, where not sketched, will be considered to be present close to the acini.

The presence of the fat seems a good evidence of the fact that we are dealing with a diffused change in the breast, and not with a widely disseminated tumor, a point insisted upon by Cornil and Ranvier.

The first departure from the normal structure is seen in the acini. The cells are increased in number and obscure the lumen, and the wall shows as a thickeneed fibrous investment, with very few nuclei.

Next several acini fuse together by obliteration of the intervening septa, a process seen in all parts of the breast in varying degrees. The cells are smaller and more irregular than the normal ones. In some places, but this is exceptional, fibrous tissue is produced at the same time, and we have the appearances of an alveolated stroma of fibre tissue, the spaces of which are filled with epithelial cells. In the centre of some

spaces is seen a lumen, while in others the cells have accumulated to such an extent as to obliterate all trace of it.

Such are the various morbid appearances seen in this breast. The sequence of events it is not so easy to arrange, for though there are some small adenomatous growths in cysts, I cannot follow the development of such out of the earlier changes detailed above.

It is important to compare this case with the sketches of the breast from Mrs. T. (Case I.), where a pure cystic change is seen, and with that of Mrs. T. (Case XX.), where a pure adenomatous growth hangs by a pedicle to the wall of a cyst. Whatever view be taken of the sequence of events in this breast, the following conclusions seem justified:

1. That the change is a general one.
2. That there is no new solid formation outside of cysts.
3. That the departure from the normal begins in the epithelium of the ducts and acini, and proceeds either toward cyst formation or fusion of many acini, to one or to both of which changes new formation of gland tissue succeeds.

It may, I think, also be surmised, when we consider the appearances presented by the large cyst in Case I., and the connection between the intracystic growth and the cyst wall in this case, that the glandular formation arises by outgrowths from the cyst wall, and is a pure intracystic growth, and not a protrusion inward of a tissue formed outside the acini and ducts. As in Cases XVII. and XX., the growth may be viewed as an adeno-sarcomatous papilloma.

CASE XXXVII.—Cystic sarcoma of right breast; ulceration of skin over it; excision; recovery. (Reported by Mr. H. Dismorr.)

Dora G., an anæmic-looking woman, aged 53, was admitted into Lydia ward on December 16th, 1873, under the care of Mr. Bryant. She had noticed for many years in her right breast a lump, at first not larger than a nut. Her sister, while in bed, had put her elbow on the patient's breast while raising herself up. This gave her a great deal of pain, and the small lump then appeared; it gradually increased in size, but did not trouble her much till about six weeks before admission, when she caught cold, and it enlarged rapidly; the skin broke in two places over two prominent lumps; the bridge between them gave way and united the separated sores; these

increased in size and discharged very much. On admission, the breast was the seat of a tumor the size of a cocoanut, which was somewhat nodulated on the surface; the skin on the inner side of the nipple was red from capillary congestion; on the outside there was an ulcerated surface five inches by four, which was in great part covered by a blackish slough. The edge of the skin, though adherent to the tumor, was not infiltrated by new growth. The glands in the axilla were enlarged, but there was no enlargement of the abdominal viscera, and the other breast was healthy.

On December 23d she was put under the influence of chloroform, and the tumor was removed by two semi-elliptical incisions, with the enlarged axillary glands. The two edges of the wound were brought together and supported by strapping. There were no adhesions of the tumor to the deeper parts. A section of the tumor showed a large single cyst with definite walls, its cavity being filled with sessile growths of a lobulated form, tough consistence, and gelatinous look. The microscope showed it to consist of a loosely fibrillated connective-tissue spindle-celled sarcoma and a larger number of round fatty nuclei scattered through it.

After the operation a morphia injection was given, which greatly relieved the patient, but she was very sick the day after, and perspired freely for some two or three days.

29th. The wound is looking very healthy, and covered with granulations. There has been a little diarrhœa, accompanied by pain in the abdomen. Temperature 98.6°, pulse 78.

January 17th, 1874. The patient has gone on improving; there has been a good deal of perspiration, at night particularly, after which she complained of weakness, but her appetite has been good. Six pieces of skin were transplanted to the wound, four of which seem to have taken. She gets up for an hour or two in the day. The wound decreased in size, and on the 27th was the shape of a triangle, each side being about two and a half inches long.

29th. Eight pieces of skin were transplanted, six of which were thought to have taken five days later from this time. She went on capitally, and left the hospital on February 9th, the wound having lessened in size half an inch in ten days.

This patient was known to have been well three years later.

Case XXXVIII.—Cystic carcinoma of breast; excision.

Miss S., about forty-five years of age, consulted me on December 19th, 1884, on the advice of Mr. Bisshopp, of Tunbridge Wells, for a tumor involving her right breast of more than two years' growth. She was first seen by Mr. Bisshopp in November, 1882, when the tumor had been discovered some months. It was then hard, but painless; it grew gradually. When I saw her the whole breast seemed to be involved in the disease, and was hard and nodular. The nipple and skin over the breast were natural. I regarded the case as one of cancer, and advised its speedy removal. Sir James Paget saw the case and gave a like opinion. On January 9th, 1885, the operation was performed, and the wound healed at once by quick union.

The lady is now (two and a half years after the operation) well.

Report of Tumor by Mr. Symons.—The tumor was situated beneath the nipple in the substance of the breast, and measured about one and a half by two inches. The section when fresh showed a pinkish color, with many yellow spots resembling altered secretion, plugging ducts. There were, besides, many larger spaces with smooth walls filled with a yellowish-gray or darker thick fluid. The tumor was not limited by any capsule, but blended directly with the breast, and in some places with the adipose tissue. When a thin slice was cut and the yellow contents of the spaces removed, the whole closely resembled cavernous tissue, so numerous were the spaces and so scanty the stroma. Examined microscopically in water, the yellow material was found to be composed of cells of all shapes, and in all stages of degeneration, the prevailing shape being an irregular columnar. Numerous fatty granules, and plates and rounded or irregular masses of carbonate of lime also were present.

The microscopical appearances are shown in the drawing below (Fig. 11), made under a low magnifying power. The spaces are of various sizes and shapes, are all of a tubular character, and most of them have a distinct lumen, occupied when fresh by the yellow material above described, and which has nearly all fallen out in the preparation of the section. The epithelium lining these spaces is arranged mostly in a double or triple layer, having a distinct dark line where, uniting, they limit the lumen, an appearance resembling the striated border

of Brücke. In other spaces the epithelium is more abundant, and forms irregular elevations projecting toward the lumen, which is in some instances entirely obliterated. Under a high power this last arrangement closely resembles an alveolus of an ordinary carcinoma of the breast. The stroma is fibrous, with very few nuclei or vessels, differing in these respects markedly from the stroma of new growths generally. The epithelial cells are large, angular, closely fit into one another, and have prominent round or oval nuclei. As they increase in number many become granular and some vacuolated.

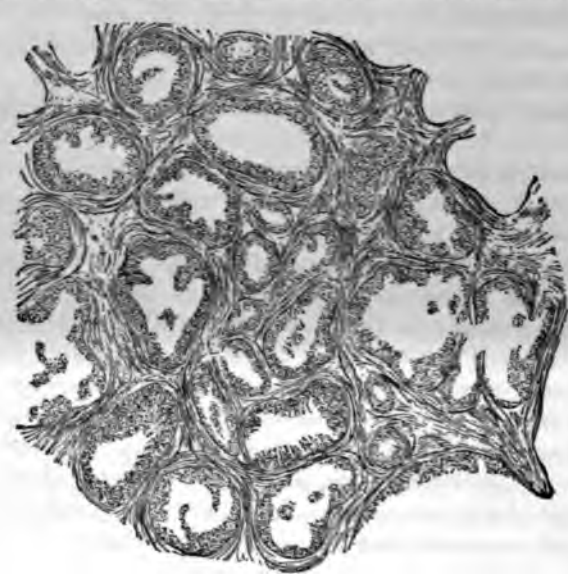


FIG. 11.—Tubular Carcinoma of Breast. Case 38.

The growth was not confined to the nipple, but was placed somewhat below this point. Moreover, it invaded the surrounding adipose tissue. On these grounds, and on account of the large size of the tumor, the large number of the spaces, and the absence of any large cysts, the formation must, I think, be considered as no mere duct dilatation, but a new growth, the prevailing character of which is its tubular form. This character is determined probably by the seat of origin, for when contrasted with another case, that of Mrs. T. (Case I.), the absence in all the sections of ordinary breast tissue and fat confirms the view that this is a new formation.

CASE XXXIX.—Cystic cancer of breast.

Miss B., aged 43, for ten years has had clear discharge from her left nipple, gluing it to her linen. At times the discharge has been blood-stained; she has had occasional sharp pain in the breast. The catemenia regular.

Seven years ago the lump was the size of a nut; now (April, 1882) it is the size of an orange.

The lymphatic glands and the skin over the breast are healthy. Breast excised by Mr. Shipman, of Grantham, and found to be cancerous.

The growth had clearly grown from a cyst.

CASE XL.—Cancer of breast following cystic disease coming on after prolonged suckling.

Sarah C., aged 44, the mother of one child, which she suckled for three years up to six weeks ago, applied to me on April 25th, 1865, for a soft swelling the size of an egg in the outer lobe of her right breast. It was fluctuating, and had been coming two months.

Under tonics the swelling seemed to get smaller, but in June the skin over it became adherent, and in July pus escaped from the nipple.

On August 17th the cyst burst and discharged a yellow serous fluid. The case then did well.

In January, 1866, patient reappeared with the breast generally infiltrated and fixed to the chest; the skin over the breast was likewise infiltrated, and in one spot ulcerated.

At this time the diagnosis of an acute carcinomatous infiltration of the breast was easily made, and from the history of the case it seems probable that it originated within the cyst of which the report gives a history.

Had the cyst been excised when first treated, the cancerous disease might have been prevented.

CASE XLI.—Cystic carcinoma of breast following blood cyst; excision of breast; return and death in one year.

Mrs. C., aged 58, nursed eight children without trouble. Lump in right breast for six months, having been preceded by a discharge from the nipple of blood for one and a half years. When I first saw her on May 5th, 1876, there was a cyst the size of a walnut on the outer side of her right nipple. By pressure all the sanguineous fluid could be squeezed out of it, and the wall of the tumor fell in, leaving a concavity.

Pressure was applied to the tumor by cotton wool and strapping.

November 29th. No tumor can be felt. The hollow beneath nipple is still distinct. No discharge from nipple for three weeks.

July 28th, 1879. After the lapse of three years nipple retracting; some thickening in seat of cyst. No discharge from the nipple; skin slightly infiltrated over seat of old cyst. No axillary glands enlarged.

August 6th. Excised breast; good recovery.

June, 1880. Died with internal cancer.

The interest of this case rests on the fact that for at least four years before any symptom of local cancer appeared there was clear evidence of the presence of a duct cyst. That the cancer developed in the cyst there can be little question, since it was in the seat of the cyst and of the gland over it that the first signs of carcinoma appeared.

It was a source of regret to me when I saw this serious trouble, that excision of the breast had not been performed earlier. The results might then have been different.

CASE XLII.—Carcinoma involving a mamma the seat of cystic disease; excision; return five years later.

Mrs. S., aged 42, the mother of one child, consulted me in February, 1876, for a tumor in her left breast which she had discovered four months, and which had steadily increased.

The tumor was situated in the axillary lobe of the gland; nipple natural; axillary glands free. The growth was clearly scirrhous.

Excision.—Axillary lobe infiltrated with carcinomatous material and simple cysts in other parts of the gland, one filled with inky fluid; no intracystic growths.

Good convalescence.

Remained well for nearly five years, that is till December, 1881, when signs of return of cancer appeared in the cicatrix.

CASE XLIII.—Cystic carcinoma of breast following upon ordinary scirrhus.

Ann C., aged 60, came under my care in July, 1864, with an infiltration of her right breast. Three months later the skin over the gland became adherent and infiltrated, and the axillary glands enlarged.

In April, 1865, a cyst appeared in the upper part of the

tumor, and rapidly increased, so much so that in July it threatened to burst. This, however, did not take place. In September chest complications appeared which destroyed life.

CASE XLIV.—Cystic carcinoma of breast; excision; cure.

Ann C., aged 49, the mother of five children, all of whom she suckled.

For four and a half years she had discharge of blood-stained fluid from the nipple, which could be increased by pressure.

The gland had steadily enlarged during this period.

April 17th, 1865. Breast large and nodular. The skin was adherent to the breast, and the nipple was retracted, the tumor was clearly cystic in its nature. The breast was subsequently excised and the patient recovered. The disease was, as suspected, cystic carcinoma, the gland being full of cysts, and the cysts of intracystic carcinomatous growths.

CASE XLV.—Cystic carcinoma of breast; sloughing of growth; hemorrhage; removal; relieved.

Harriet A., aged 70, was admitted into Lydia ward on January 28th, 1879, under Mr. Bryant. She has had four children, the youngest of which is now thirty-five years of age. There is no history of tumors, and patient has always been healthy.

The patient first noticed a small lump in the axillary portion of her left breast ten years ago, and it has continued to increase in size since. On Friday evening last it began to weep with blood.

On admission. The left breast is occupied by a hard infiltrating growth which implicates the skin and deeper parts, extending from near the left border of the sternum to the middle of the axilla, and from the third rib above to a point in a line with the ensiform cartilage. The breast is not distinguishable, and the site of the nipple is occupied by a depressed ulcerating induration marked with dilated vessels: the ulceration is superficial, and covers an area an inch in diameter. External to this is a large, oval, fluctuating swelling, limited above by a deep furrow. The swelling is about three inches by two; the skin over it is thin, red, and livid; about the middle of it is a black spot, from which the hemorrhage took place on the 24th inst. There is no enlargement of the axillary gland.

On the 28th and 29th more hemorrhage.

January 30th. The cyst has collapsed; the skin around the opening is sloughing, and it is discharging a fœtid grumous-oking material.

January 31st. *Operation.*—Two elliptical incisions were made from the median line of the body running obliquely ownward and outward, about five inches in length, and three ches apart at the centre. The whole of the breast and car-oma were removed as far down as the pectoralis major. wound was washed with warm iodine water, two silver res were introduced at the upper angle of the wound, and ce of terebene lint applied over it with a bandage to keep ressings in their place.

February 2d. The wound was dressed and the silver su-s removed.

arch 10th. The patient was discharged to-day convales-nt.

The walls of the cyst after excision on section showed small und cells. The hard mass was evidently scirrhus undergo-atty degeneration. It was in one large cyst which had red. There were other cysts filled with cancerous growths.

Case XLVI.—Cystic carcinoma of mammæ, with cystic degeneration of breast; excision; relieved.

Mary Ann W., aged 50, was admitted into Astley Cooper ward on June 15th, 1878, with a hard swelling reaching from the nipple upward two inches. The nipple was retracted and the skin was adherent to the growth beneath. The axillary lymphatic glands were not enlarged. Her previous history was good, as was that of her family.

It was only about six months before her admission that she first noticed a little pain in the breast and a dimpling of the skin, beneath which was a small lump. The lump increased in size, and became very painful when touched. She then saw Mr. Bryant, who advised the removal of the breast.

June 16th. Chloroform was administered, and the breast removed. The mass was found to be cancerous, and cysts were found to be freely distributed throughout the gland tissue.

She left the hospital on September 17th convalescent.

Case XLVII.—Recurrent carcinoma of mamma; excision; relieved; carcinoma of cyst.

Jane R., aged 47, a married woman, was admitted into Lydia ward on 15th October, 1877. She was the mother of eight children, six of whom where living, the youngest being fifteen years of age. She had suckled all her children with her affected breast.

She had always enjoyed good health until about twenty months before admission, when she noticed for the first time a little lump in her right breast about the size of a walnut. Ten months later it increased rapidly.

On February 9th she was operated upon at another hospital, and the tumor was removed, leaving the breast and nipple, which were not infiltrated. She left the hospital on March 11th, with the wound perfectly healed.

On admission. The patient stated that about two months after her discharge from the hospital she noticed a slight swelling in the cicatrix of the old wound as well as pricking pains; the growth rapidly increased in size until it became a circular tumor four inches in diameter, a little to the right of the sternum. It was hard to the touch, movable over the pectoral muscles, and infiltrated the skin for three inches. The skin was purple and shining, and had about its centre a small prominence.

October 23d. Chloroform was administered, and the tumor was removed by two incisions, inclosing a space about five by six inches; there was but little hemorrhage. The growth had to be dissected off the pectoral muscles. The incision left a large cavity, into which a porringer without the handle might be embedded. This was left to granulate. One suture was, however, put in at the right-hand side of the wound.

The tumor, when cut into, exhibited a large cavity containing serous-looking fluid. The walls were composed of very soft cancerous growth made up of epithelial elements.

November 16th. There was a small growth, the size of a cherry, noticed to be growing from the bottom of the fossa near the lower and right side. This was thought to be a portion of the old growth left behind after the operation. The following day it was removed. There was very little bleeding and not much pain.

December 12th. She left the hospital convalescent.

Six months later this patient was well.

In this case the evils of a partial operation for carcinoma

are well illustrated, for had the rule which is generally considered by surgeons as a binding one been observed, and the whole breast been removed when the primary tumor was taken away, the second operation would not probably have been called for.

CASE XLVIII.—Cystic sarcoma of one breast; removal; followed in nine years by cancer in opposite breast.

Mrs. W., aged 60, the mother of one child, which she could not nurse as her nipples were retracted.

Twenty years ago she had a small lump in her right breast, which disappeared entirely in the course of two years.

February, 1872. Observed a lump in the same spot, which has increased rapidly, so that now (April, 1873) it is the size of a cocoanut. Tumor clearly lobulated and cystic; axillary glands free.

The breast was removed and was clearly cystic spindle-celled sarcoma; a good recovery followed the operation.

June 14th, 1882. A tumor appeared in the left or opposite breast which infiltrated the gland, and gave rise to retraction of nipple and puckering of skin. It was an example of ordinary carcinoma.

Nothing was done, as the patient refused to be operated upon.

This case is worthy of record as an example of a patient having a carcinomatous tumor of one breast follow upon the removal of a cystic sarcomatous tumor in the other, although at ten years' interval. Such cases are rare.

I have, however, now under observation a lady, aged 68, who has had for at least twenty years a perfect specimen of scirrhous carcinoma of the left breast, which has remained unchanged for four and a half years, while in her right she has had a rapdily growing round-celled sarcomatous tumor removed with recurring growths on seventeen occasions, during these years, her general health being perfect. (See Case I., in Chapter XX.)

CASE XLIX.—Cystic carcinoma of breast.

Mrs. R., aged 83, the mother of many children, all of whom she had suckled, consulted me on June 27th, 1877, for a cystic carcinoma of her left breast which had been coming on for one and a half years.

The tumor was of the size of an orange, and fluctuating;

skin over it infiltrated, but not the axillary glands; nipple natural.

Maternal aunt had had cancer.

No operation advised on account of age.

CASE L.—Cyst in breast becoming the seat of carcinoma; removal of tumor followed by death from secondary growth five years later.

The following case, which occurred in the practice of Mr. Birkett, is a good one to show how a cyst may exist for years in a breast gland before it becomes the seat of intracystic growth. The case is described as follows in the hospital catalogue (Preparation 2,309[3]): represents a portion of the left

FIG. 12.—Cyst with pendulous Intracystic Carcinomatous Growth. Case 50.

mammary gland, consisting of cancer, which contained cysts. A large cyst (Fig. 12) is seen with a growth attached to its walls. The cyst was filled with bloody serum, and the growth consisted of the elements of carcinoma.

Case of Mrs. B., aged 40, a private patient of Mr. Birkett in 1853. Ten years before, she discovered a lump in her left breast, but suckled with it subsequently, and enjoyed good health. Five months before removal, on May 19th, 1853, the tumor became rapidly larger, and fluctuation could be detected in it. It measured more than three inches across, and occupied the axillary half of the breast.

The patient recovered from the operation, and was perfectly well for two years and nine months. A growth then

formed in the axilla, which ulcerated, and cancer was developed in other organs, and for two years she suffered intensely. She died fourteen years after the discovery of the primary growth. On post-mortem, cancer was found in the left humerus, left femur, and left innominate bone, also on the lumbar vertebræ, and in the liver.

Diagnosis of Cystic Tumors.

In the examination of every tumor of the breast, and particularly of one in a woman over thirty-five, the surgeon as a matter of habit should allow the possibility of the case having a cystic origin to pass before his mind. By so doing he will not only prevent errors of practice which may be grievous, but at the same time he will guard against sources of serious mortification, for, I take it, there are few things more humiliating to a surgeon than an error in practice based upon a wrong diagnosis, when the error is not due to the inherent difficulties of the case, but to a want of care. When the tumor is in the breast of a woman over forty years of age this caution is more necessary, for cystic tumors of all kinds are more prone to occur in women over thirty-five and past the prime of life than in younger subjects. In 1861 I, however, removed a sero-cystic tumor from the breast of a girl aged twenty, which had been growing for three years, and at the time of operation measured twenty-two inches in circumference, and weighed after removal two and a half pounds. This preparation is preserved in the Guy's[38] museum, with another[39] in which a cystic duct sarcoma of one and a half years' growth was removed from a girl aged fifteen. When the tumor seems part of the breast gland itself, and appears as a single or possibly double growth in one or more lobes of the gland; when the swelling is very hard and tense, and is not the seat of pain even when handled; when it has existed for several years, and has given rise to no other symptoms than such as are referable to its mechanical presence, the probabilities of the tumor being cystic are very great. When the swelling is bossy or botryoidal, and fluctuation can be detected in some of its parts; when with the swelling there is a discharge from the nipple, and this discharge can be increased by pressure or manipulation, the diagnosis of cystic disease is

evident, and with the nipple discharge the diagnosis of a duct cyst is clear.

Whether the cysts be simple or proliferous is another question, and if the latter, the nature of the growth they contain is still a third. In a general sense it may be said that a single cyst is more probably simple than when the cysts are multiple and form a polycystic tumor; that is, when a lobule of a gland is expanded by the presence of a single cyst, that cyst is more likely to be of a simple kind than when the cystic disease has involved more of the lobule. Simple polycystic disease of the breast is a rare affection, except as a result of general glandular degeneration. When a discharge from the nipple exists, and that discharge is bloody, the probabilities of a cyst containing some intracystic growth, however small, should be recognized, since it is from the vessels of the intracystic growth that the bleeding as a rule takes place. Simple cysts rarely bleed. When the bleeding is encouraged by or has followed manipulation, the probabilities of the cyst containing an intracystic growth are very great. When a cystic tumor exists in a lobule of the gland as a fluctuating swelling in some parts and a more solid one in others, the diagnosis of solid with cystic growth is tolerably clear; and when with this there is a free discharge of a bloody kind from the nipple, the diagnosis of cystic duct and glandular disease is highly probable. These lobular cystic tumors often present a somewhat typical shape, such as that of a pear, the narrow part of which is represented by the nipple (Plate IV., Fig. 1). Few of these tumors cause pain. Advice is sought as a rule either on account of the tumor or on account of the nipple discharge, not because of pain.

The diagnosis of a cystic adeno-fibroma or adeno-sarcoma is to be made out by attention to the same points as help the diagnosis of these growths when uncomplicated with cysts; that is, a cystic adeno-fibromatous or sarcomatous growth simply troubles from its size or from its nipple discharge. By its growth it expands the integument over it, and spreads out such portions of the breast gland as may be superficial to it, but it in no other way involves its coverings (Plate IV., Fig. 2). The skin may be stretched even to a rupture, but even then the skin as tissue will be neither invaded nor infiltrated with disease. The cysts themselves may even

burst and discharge their contents externally, but under such circumstances the integument that fringes the edges of the ruptured orifice will still be seen free, and can be readily distinguished even from the extruded or extruding intracystic fungating contents (Plate IV., Fig. 3). The nipple may be so flattened out as nearly to be indistinguishable, but it will only in very exceptional cases be drawn in by the disease, as seen so frequently in cancer; and even should it be drawn in, inquiry will generally reveal the fact that such a condition was either congenital, or that some cicatrix of a former abscess had altered its normal shape. Should the cyst be, however, more central and separate the lactiferous ducts, nipple retraction is to be expected.

The lymphatic glands (axillary and clavicular) will rarely be involved; when they are they will be affected actively from lymphatic irritation rather than from lymphatic absorption, and under such circumstances the enlargement is more frequent when the cysts have burst through and irritated the skin than under other circumstances. In some forms of rapidly growing cystic sarcomatous as well as solid sarcomatous tumors, the lymphatic glands are, however, seriously affected.

The diagnosis of cystic carcinoma will turn upon the same points as that of the more common kind of cancer. Though the growth may have orignated in a tube or cyst, it will not long be confined in its capsule, for, obedient to its nature, it will invade its cyst walls and creep into the tissue outside. The tumor will then spread into the neighboring parts by the one marked way in which carcinomatous tumors locally spread, viz., by steady and progressive infiltration or local infection; the carcinoma in its progress having first infiltrated the cyst in which it originated, then the tissues outside the cyst, later on those which surround these, and last of all the integument itself (Plate IV., Fig. 4). The infiltration of the integument first shows itself as a "dimpling" (Plate II.) of the surface, next as a "puckering" of the skin, thirdly as an "infiltration of the skin," and lastly as an ulceration. Should a cyst so enlarge as to encroach upon and infiltrate the skin, and later on rupture through it, the intracystic carcinomatous growth will project and grow through the opening, but the edges of the orifice through which the intracystic growth projects will be found everted (Plate II., Fig. 6), and

involved in the disease, and not, as described in the cases of cystic sarcoma, simply ruptured. The infiltrating tendency of the disease is marked in all its stages from its first to its last. The intracystic growth will never project and fungate in the way of sarcomatous growths. Should the nipple be affected by the disease, it may first be as a conduit for the discharge through the milk ducts, but later on, when the disease has left the cyst and invaded the tissues outside its borders, it will be affected in other ways. When the tumor by its growth has drawn upon the suspensory ligaments of the glands and ducts of the nipple, some retraction of the nipple will ensue, and later on, should the nipple itself become materially infiltrated, there may be actual projection. At times there may be such infiltration and contraction of the tissues around the base of the nipple as to produce œdema of it from blood stasis, and in rarer cases even sloughing.

The lymphatic glands, axillary or clavicular, will become affected in the cystic form of carcinoma as they are known to be in the non-cystic kind, and they will be affected in the same way. In fact, the progress of a case of cystic carcinoma is similar in kind to that of the more solid form of cancer. At the beginning it may possibly be slower, but when the disease has extended beyond the cyst wall or walls, I am disposed to think it is often more rapid.

Prognosis.—A careful perusal of the fifty cases quoted in this chapter (and I have published all of which I have satisfactory records) will lead the reader to form a very favorable opinion of the future prospects of those who suffer from any cystic breast trouble, and have been surgically treated. This remark is applicable to every variety of cystic disease with the exception of the carcinomatous. Where the cyst is simple, a cure can safely be predicted by surgical treatment, which may sometimes be of the simplest kind, such as merely puncturing the cyst and drawing off its contents. Sometimes it may be brought about by a free incision; in exceptional cases by excision. But by whatever means the cyst is abolished, a subsequent cure may be anticipated.

Whether it is wise to leave the disease alone is a question somewhat difficult to answer, but there is no doubt that in the cases recorded in which solid material was mixed with the cystic, the simple cystic element formed the beginning of the

trouble; for in many of the cases a "lump" had existed in the breast for years (associated in some with a discharge from the nipple, which revealed its cystic nature) before any signs or symptoms of the presence of the more solid elements appeared. Under these circumstances it is not unfair to infer that if the simple cyst had not been allowed to remain, but had been treated, the more serious breast trouble which eventually attacked the different patients, and originated in the cyst, would not have manifested itself. If these remarks are applicable to the cases of simple cysts, they are clearly more so to those of a more complicated kind, such as the sero-cystic tumors. The prognosis in these cases after treatment is most satisfactory; indeed, a cure may with some confidence be predicted. In the four cases I have recorded the patients were known to have been well from six to eleven years subsequently, and, in fact, cured.

In the examples of cystic adenoma or sarcoma, the prognosis is no less good; indeed, if I am justified in taking my own cases as examples of all others, I might say the prognosis is very good, for of twenty-one cases recorded, sixteen of which were treated by excision, in no instances was there any known return of the local affection, and six of the subjects of the disease were known to have been alive after the operation for five, six, three, seven, eight, and twelve years respectively; while one died three years after having been relieved of her local trouble, from acute bronchitis. One patient with adeno-cystic sarcoma of one breast had a carcinoma of the opposite breast nine years later.

In cystic carcinoma a hopeful view may likewise be taken, for of my own nine cases which were treated by operation, one was known to have been alive two years, and another five years, after operation; while a third remained well for nine years, when the opposite breast became the seat of an ordinary scirrhus. One other case died one year, and a second four years after operation, from internal cancer.

Treatment of Cystic Disease of the Breast.

In all cases in which the true cystic nature of the tumor is doubtful, an exploratory puncture with a small aspirating needle should be made, not only for diagnostic purposes, but

with the reasonable prospect of retarding if not arresting the progress of the disease, and this hope may reasonably exist should the disease consist of the dilatation of a single duct, for I can recall not a few examples of what turned out to be simple serous cysts of the breast which had been tapped for diagnostic purposes in which, after the lapse of years, no return of the trouble has taken place. When a simple tapping has proved ineffectual or was inapplicable, an incision into the cyst, its free drainage, and healing by granulation, may bring about a cure, but these means should only be adopted when the cysts, on being laid open, have been found quite free from all signs of intracystic growths, and the cyst is single. When more than one cyst exists in a lobe this treatment is hardly applicable, and the safer practice is to dissect out the cysts with enough of the surrounding gland to make it reasonably probable that the disease has been wholly removed. When the cyst contains an intracystic growth it must be freely excised, and should more than one such cyst be made out, the whole gland had better be extirpated, for all proliferating cysts are prone to grow, and the breast glands of such as contain them are rarely only locally implicated. I have, on many occasions, after the removal of a cystic sarcomatous tumor, found such portions of the gland as seemed to be healthy, the seat of the same disease only in miniature (Case XXI.), and this fact fairly suggests that the disease, although palpable in one part and apparently local, is really a general gland disease, and that under such circumstances the whole gland had better be excised.

In the more solid forms of cystic sarcoma and cystic carcinoma, early excision is a rule of practice which should never be deviated from.

CHAPTER XVII.

GALACTOCELES AND HYDATIDS.

***Milk* or *lacteal cysts*, or galactoceles, are comparatively rare cystic tumors of the breast. They form when the gland is in a state of functional activity, and usually during the first three months of lactation. Exceptional cases are met with which appear at an earlier as well as at a later period. I shall record one which appeared during the ninth month of lactation. Atlee published in the "American Journal of Med. Science" for April, 1874, an example which developed sixteen months before childbirth, and increased rapidly during pregnancy; and Bouchacourt, as recorded by Richelot, has reported an instance which occurred in a woman, aged 51, twenty-four years after her last confinement.**

As indicated by the name, the cysts always contain milk, cream, or a buttery material, which is clearly the product of milk; and these variations in the character of the cystic contents are manifestly due to the changes which the fluid undergoes after it has been extravasated into the gland.

At times the tumor follows a blow or some inflammation, but as a rule it appears without any known cause during full lactation. The tumor is doubtless generally due to a rupture of the milk ducts, and consequent extravasation of milk into the connective tissue of the gland, although in some cases it may be caused by the obstruction and subsequent dilatation of a lacteal duct.

In one case the tumor will increase rapidly in size, and Birkett states that it may increase rapidly and distinctly during every time the infant sucks. In another it may appear suddenly, increase slowly, and then, as far as size is concerned, either remain stationary or even diminish, the diminution in size being occasioned by the absorption of the watery constituents of the milk, and its consequent concentration.

With respect to size, cases are on record in which several

pints of milk have been evacuated. Scarpa is reported by Forget to have recorded an instance in which two pints of milk were removed from the tumor; and Birkett gives another from which, after excision, ten ounces of thick cream flowed away.

In the Guy's Hospital museum there is a preparation (2290[80]) of a large cyst which Mr. Birkett removed from the breast of a married lady, 27 years of age, which had been increasing for eight years. The cyst contained fluid composed of milk and serum, and in the walls of the cyst were several small adenomatous growths. It is probable that those growths were secondary to the formation of the galactocele.

At the same hospital (Preparation 2290[50]) there is also a breast removed from a middle-aged patient, for a tumor containing cheesy matter, occasioned by obstruction of a lactiferous tube. A thin translucent membranous expansion exhibits the boundary of the cyst, but all the contents have been removed. The tubes of the gland generally appear dilated, and pieces of glass rod are placed therein. There is no duct at present traceable to the cyst.

The signs and symptoms of this affection are more negative than positive. The one positive sign is the presence of a more or less globular swelling in a breast which is performing its physiological functions with full activity; one that may increase rapidly, or on the other hand, very slowly, and that gives rise to trouble mainly from its size. If it causes pain, it will probably do so from its weight. If it is attended with external evidence of venous congestion, as indicated by full veins, it will be so on account of its size. When the contents of the tumor are liquid, there will be fluctuation. When the fluid has been partially absorbed, and the contents are as it were condensed, the tumor will yield a doughy and peculiar feel. When the contents have become desiccated and a cheesy mass is left, it will present more the physical features of an adeno-fibroma or sarcoma. When it occurs during the period of suckling, and the child is put to the breast, pain is often produced. "The pain and distention (of the cyst) being increased by the draught of milk which enters the breast so soon as the child begins to suck" (Sir A. Cooper).

Should the lacteal cyst occupy the posterior part of the gland, and consequently be covered in front with a thickness

of breast tissue, the globular swelling of the tumor will be obscured, and it may feel nodulated, the coarse, active gland tissue surrounding the cyst giving rise to this condition.

The nipple is not affected in this trouble, although at times it may discharge milk. When this symptom is present during the lactating period it is of no value, but when it exists after the breast has ceased this function, it is of great use; since it fairly shows that the cyst contents communicate directly with a duct, and thus suggests the diagnosis.

At times the tumors are multiple. I have seen two in the same breast. In this case the tumors were of the size of small eggs. They had appeared two years before I saw them, during lactation, and had for one year steadily diminished in size, even to a half, but since then they had been stationary, but felt doughy to the touch, and could be moulded to a degree like clay; that is, the side of one of the tumors could be made flat or convex by pressure. The second tumor could not be so altered, but it was placed more deeply in the centre of a lobe, and had the feel of a fibroma. I cut into both tumors, and evacuated from one what might have passed as excellent clotted cream, and from the other a cheesy material, which represented the cream still more condensed. This case was in a lady about 35 years of age, and the tumors had appeared during the lactation of her first child, two years previously.

A cystic tumor of this kind may therefore decrease in size, from absorption of its fluid contents, and as it decreases become more solid.

Treatment.—These cases, when met with in the months of early suckling, or when that function is in full activity, are not to be allowed to drift, for the milk will not be re-absorbed, and, if re-absorption does not take place, the increase of the tumor may be expected as long as the functional activity of the breast continues. It is wise, therefore, should the swelling be large, to take the child away from the breast with the hope that with the disappearance of the secreting action of the gland, any increase of the tumor will be prevented, and its decrease encouraged; when the cyst is small suckling may be continued. Should this decrease in size not ensue, the cyst should be aspirated and its contents drawn off. Should it then refill and the operation prove unsuccessful, an incision

should be made into the cyst and its contents evacuated. The incision should be a free one, for if a small one be made, it will soon close, and a re-accumulation of milk will take place, or a milk fistula will be left. This milk fistula will last as long a the breast is active, and cease to discharge only when secretion has stopped.

The more chronic cases are to be treated as those of simple cysts, that is, by a free incision, the evacuation of the cyst contents and the subsequent closure of the cyst cavity by granulation. In the case recorded, where solid contents existed, this method of treatment was successful. In the following case, where the fluid was cream-like, a similar result ensued.

CASE I.—Galactocele followed by pregnancy and suckling of child from affected breast.

Susan T., 35 years of age, who was confined thirteen months previously, and suckled for ten months, came to me on October 5th, 1865, with a globular tense swelling, the size of an orange, in her right breast, which had been coming four months, that is, from the sixth month of lactation. On November 20th the tumor was punctured for diagnostic purposes, and then freely opened, at least six ounces of cream exuding. A good recovery ensued.

On September 25th, 1866, this patient again came to me when she was pregnant nine months. The breast was then apparently quite healthy. She was confined on October 4th, and suckled well. No breast trouble following.

CASE II.—Galactocele of eleven years' standing, suppurating after fourth confinement; treated by free incision and cure.

Annie S., aged 31, the mother of four children, the youngest being nine weeks old, came under my care on April 1st, 1874, with a tumor in the upper part of her right breast, which measured three and a half by two and a half inches in diameter. The skin over the tumor was adherent to it. The nipple was retracted.

Thirteen years before, when only 18 years of age, after a blow, she had pain in her right breast; two years later she married; when suckling her first child she noticed a small lump, the size of a walnut, on the upper part of her right breast. This never left, but after each of her confinements

(four) increased in size. Between the periods it remained stationary. After her last confinement, nine weeks before admission, the lump increased rapidly, became painful, inflamed, and suppurated, some ounces of pus escaping.

She had never been able to suckle with the right breast, as the nipple was too flat.

A galactocele being diagnosed, I made a free incision into the tumor, and turned out a cupful of cream-like fluid, after which the cavity closed and recovery ensued.

Treatment.—The operation required is a free incision into the cyst in a line radiating from the nipple, followed by the thorough evacuation of the contents of the cyst and its perfect ansing with iodine, or other antiseptic lotion. The cyst ould subsequently be plugged with iodoform, carbolic, or uze, to promote healing by granulation. The cyst t, in very chronic cases, be well sponged with a ain to the ounce solution of chloride of zinc, or with tincture of iodine before plugging. The wound should open to heal from below.

Hydatids in the Breast.

These cysts are found occasionally in the breast gland, as they are known to occur in any other part of the body. How they get there is a question which need not be discussed in these pages.

When such a cyst appears in the breast, it does so as a single, painless, tense, elastic, globular swelling of some portion of the organ unassociated with any morbid condition of the breast gland or nipple, or parts over the breast. It gives trouble merely mechanically by its size. After a period, and, it must be written, a very uncertain period, the hydatid will die, and under these circumstances the parts around will inflame and suppurate; the abscess eventually, if left to nature, opening and discharging; the dead wall of the hydatid in this way escaping. Indeed it is by the escaping of the dead entozoon that the true nature of the case is sometimes for the first time revealed.

These cysts have been found in women of all ages, from twenty-three upward. They grow slowly, at times very slowly; in two of the cases I record the tumor had existed for

eight and eleven years respectively. In exceptional cases they attain the size of an orange rapidly.

They are without doubt difficult to diagnose from cystic disease of the breast, or some neoplasm, and more particularly when they are small. These tumors are, however, always single, and attain a larger size than most cysts; they are never associated with discharge from the nipple. Their true nature can, however, be readily made out by an exploratory puncture, and an examination of the fluid drawn off. The fluid of the hydatid being clear, or very slightly opalescent, alkaline, sp. gr. 1007 or 8, and non-albuminous; whereas the fluid of most, if not all, gland cysts is albuminous. When the characteristic hooklets are found in the fluid the diagnosis of any case is certain. Should the cyst hold a superficial position in the gland, its globular outline will be readily recognized; in the case from which Fig. 8 on Plate IV. was taken, this point is well illustrated. The case was one which occurred in the practice of my colleague, Mr. Symonds.

CASE I.—Hydatid of the breast.

Mary A. H., aged 30, a widow, came under my care at Guy's Hospital, in October, 1865, with a smooth, globular, fluctuating swelling, the size of a cocoanut, occupying the upper half of the left breast. She was a healthy woman, the mother of three children (the youngest being eight years old), all of whom she had suckled.

The tumor had been growing for five years, and had appeared as a small, hard swelling, the size of a nut, above the nipple, and apparently deeply seated in the gland. It had grown steadily, although during the last twelve months its increase had been more rapid. It had never caused any pain, and had troubled her chiefly on account of its size.

The tumor and breast seemed to be one, and the gland moved freely over the deeper parts. The nipple was natural, and the skin over the breast was not implicated. There were no enlarged lymphatic glands.

The diagnosis, in this case, was not easy; the swelling was evidently cystic, for all the symptoms indicating a cyst were well marked. The history of the case, and the almost total absence of pain and of all such symptoms as generally indicate suppuration, went far to prove that the swelling was not

due to the presence of a chronic abscess. The nature of the swelling, and the apparently perfect healthiness of the uninvolved portion of the mammary gland, with the absence of nipple discharge, contra-indicated the presence of ordinary cystic disease of the breast. The origin of the swelling, as a small tense tumor, and its gradual and painless enlargement, unaccompanied by any definite symptoms of disease of the mammary gland, were indications enough to excite a suspicion of its hydatid nature, but the extreme rarity of such an affection forbade any positive diagnosis being made.

I therefore punctured the cyst with a trocar and canula, and drew off a few drops only of a thin watery fluid containing flocculi of a delicate membrane, such as was at once recognized as the lining membrane of a hydatid cyst. On this diagnosis a free incision was then made into the tumor, and out came a large parent hydatid cyst, with many daughter cysts. The whole measuring seventeen fluid ounces.[40] Under the microscope, micrococci were clearly seen, and the diagnosis established. The cavity from which the hydatid escaped was left to granulate, and in three weeks the woman was well.

I have given this case in full, with some remarks I made with reference to diagnosis, when I originally showed the hydatid tumor to the Pathological Society on November 7th, 1865, for it contains within itself an epitome of the history and progress of all similar cases, and likewise illustrates the line of treatment which should be adopted for diagnostic as well as curative purposes.

In 1866 a woman was admitted under the care of Mr. Hutchinson, into the London Hospital, for some injury. It was then found that she had been twenty years before in Guy's Hospital for some breast trouble, and that a healthy cicatrix existed on the site of her right breast. Mr. Birkett, to whom Mr. Hutchinson then referred, found that this woman had been in 1846 a patient of Mr. Bransley Cooper, who had removed her breast for a supposed tumor, which turned out to be a hydatid.

The woman when under Mr. Cooper, was a widow of 51 years of age. She had had a swelling in her breast for eleven years, and for eight it had been painless; for the last three years it had caused her inconvenience, probably from its size.

It was about three inches in circumference, firm, and apparently solid. On this account the breast was excised. After its removal its hydatid nature was discovered. The woman made a good recovery.

In the Guy's Hospital museum there is a preparation (2291) taken from a patient of Mr. Cooper Forster's, which supports the points illustrated by my own case. It was removed from a married, prolific, healthy woman, aged 29, in the year 1856, who, six years previously, had observed, when she was only 23 years of age, and while suckling her first child, a small hard pea-like swelling in the axillary lobe of her right breast. It was painless, and had increased slowly. When admitted into Guy's the tumor measured four inches in diameter, and was hard and elastic, but fluctuation could not be detected in it. It moved freely with the breast. Manipulation caused pain. It was explored by an incision, and the parent cyst, containing daughter cysts and limpid fluid, escaped. A good recovery ensued. Fig. 7 on Plate IV. illustrates the case.

Occasionally, as already stated, these hydatids die, and when they do, they excite irritation, inflammation, and suppuration. Suppuration is in a measure curative, since it is the way nature adopts to get rid of its unnatural lodger.

In Prep. 2291[10], Guy's Museum, a hydatid discharged by suppuration may be seen; it occurred in the practice of Mr. Birkett, and I had the advantage of seeing the case, the details of which are as follows:

Case II.—Hydatid in the breast; suppuration; cure.

A married woman, aged 24, was admitted into Guy's in November, 1866, under the care of Mr. Birkett. She looked delicate, but stated that she had always enjoyed good health. She had, four years previously, given birth to dead twins, and had not since been pregnant; suckling, therefore, had never occurred. Eleven months before admission she accidentally discovered "a small lump" on the sternal half of her left breast, which slowly enlarged, but was unattended with pain, until about three or four months since. A month before admission the skin over the tumor became red, the tumor itself became larger, and more prominent; for the first time also it became painful.

When admitted the whole of the sternal half of the left

breast formed a tumor, the skin covering which was red and painful when touched. The outward appearances were those of slow inflammation preceding suppuration, the skin here and there having a purple congested hue. After a few days, fluctuation in the tumor was clearly felt, and the skin began to ulcerate. Four openings altogether appeared, the largest being about half an inch in diameter. Thin, but fairly good s escaped from the apertures for three or four days, when the as she removed the dressing, discovered the yellowish- hydatid membrane, which had escaped from the largest ening in the breast, lying upon the dressing. After the es- of the hydatid the opening in the integument soon healed.

is case is an excellent one to illustrate a method that occasionally adopts to get rid of a hydatid cyst. In present case the cyst was in the breast, but the method of cure would have been the same in other parts. Had the true nature of this tumor been understood, a more rapid cure would ave been brought about by a free incision.

By way of summary it may be stated that hydatid tumor of the breast is generally discovered by accident, as a small, hard lump, imbedded in one of the lobules of a healthy adult woman; that it increases, as a rule, slowly and painlessly, and gives trouble solely by its size. As it grows it becomes so identified with the breast tissue as to move with the gland, and to appear as part of its structure. When it has attained the size of an egg, the sensation of fluctuation may be detected in it, and however much the integument may be raised by the tumor it will always maintain its healthy appearance.

At an uncertain period of the cyst's life the tumor will become the seat of a subacute or chronic inflammation which will end in suppuration, with the eventual discharge of the hydatid, and the cure of the case. The period at which this result will ensue is, however, too uncertain to base a treatment upon. From the process employed by nature we can, however, learn our lesson as to treatment, and turn the cyst out of its bed through a free incision as soon as a diagnosis of the case as been made. The cavity in which the hydatid rested will, on its removal, rapidly contract, and a recovery take place.

For diagnostic purposes in this as in the other cystic tumors to which attention has been directed, the use of the exploring

needle cannot be too strongly advocated; for by it, and it alone, can the true nature of the case be at once made known.

Sir A. Cooper originally described these cases, and illustrated them in his work on the breast (1829).

Haussmann, of Berlin, has recently given a good description of them.[41]

CHAPTER XVIII.

SUMMARY OF THE DIAGNOSIS OF TUMORS OF THE BREAST.

To help the practitioner on the question of diagnosis of a mammary swelling, the following conclusions have been drawn ch it is hoped may prove of assistance.

nors that arise during lactation are probably milk e., galactoceles or inflammatory swellings and ab-

nors that are found to be in, but not connected with ast; that can readily be made out to be distinct from , and moved without causing dragging upon the nip- are presumably of the benign kind. If they are of slow growth, hard, inelastic, and lobulated, they are probably of the adeno-fibromatous variety; if of more rapid growth, smooth, somewhat elastic, and only slightly lobulated, adeno-sarcomatous; and if hard in parts, and soft in others, clearly fluctuating and bossy, they are probably cystic sarcomatous growths, or colloid.

3. A tumor that infiltrates a lobe or lobes of the breast, which cannot be separated from the gland and has no distinct boundary, is in its nature either inflammatory or cancerous; the lobe or lobes affected being in one case infiltrated with inflammatory products, in the other with epithelial elements.

4. When the affected breast has been physiologically active, or the seat of injury; when the swelling is ill defined and the mammary gland feels leathery, or painful and elastic, and when more than one of its lobes is separately involved, the probabilities of the affection having an inflammatory origin are very great; although when the infiltration has attacked an inactive or obsolete breast, appears as a single tumor, is hard, and nodular, the prospects of the tumor being cancerous are reasonable; and when, in addition to these special local

symptoms, there is either "dimpling," "puckering," or infiltration of the skin over the tumor, or the tumor with the breast is fixed to the deeper structures, the diagnosis of cancer is confirmed.

5. Any globular, smooth, tense tumor, situated within and apparently forming part of a breast, should be suspected to be of a cystic nature, and when the tumor is associated with a discharge from the nipple of a clear or blood-stained serum this suspicion is much strengthened.

6. When more than one globular swelling is present, or the breast feels coarse to the hand, the gland is probably the seat of cystic degeneration or of involution cysts. When the tumor is single and there is no nipple discharge the tumor is either a chronic abscess, a serous cyst, or a hydatid.

7. When the tumor is punctured for diagnostic purposes, and the fluid withdrawn is brown, mucoid, blood-stained, or blood, the cyst is probably of duct origin; and in proportion to the amount of blood in the fluid is the diagnosis of an intracystic growth to be made.

8. When the fluid is clear and albuminous, the cyst is probably serous; when watery and free from albumin it may with confidence be pronounced to be hydatid. Under these circumstances the characteristic hooklets will be found in the fluid.

9. A slowly growing tumor, which has shown no signs of inflammation in its origin and progress, that eventually becomes the seat of inflammation as indicated by local redness, swelling, heat, and pain, may be either a suppurating hydatid tumor, or a gummatous or tuberculous inflammation of the breast.

10. A solid or cystic tumor, however large, that simply distends the integument over it and has no tendency to infiltrate it, is clearly a solid or cystic adeno-fibromatous, or adeno-sarcomatous growth.

11. A solid or cystic tumor, however small, that gives rise either to dimpling, puckering, or infiltration of the skin over it, becomes fixed to the deeper tissues and is complicated with enlargement of the axillary or clavicular lymphatic glands, is certainly a cancer.

12. A flattened or retracted nipple associated with a tumor may be a symptom of small or great significance. If not con-

tal in its origin, or due to some antecedent inflammation, the flattened condition of the nipple may be brought about by a simple stretching of the gland, the result of continued growth of a simple neoplasm, whereas the retraction of the nipple may be produced either by the contraction of a scirrhous tumor infiltrating the lobe of the breast, and dragging upon its ducts, or by the presence of some adenoid, sarcomatous, or cystic tumor in the centre of the breast, and so separating its ducts as to bring about a drawing in and retraction of their terminations.

13. A tumor that ulcerates upon its surface and becomes excavated by the extension of the necrotic ulcerating process, is most probably cancerous, and when the edges of the ulcer are raised, indurated, and everted, the diagnosis is confirmed.

14. A tumor that presents a prominent fungating mass fr[illegible]ne parts of its surface, and this mass projects from an [illegible]ich has punched out and not infiltrated edges, is cer-val [illegible]rcomatous, and probably cystic. A slow-growing [illegible]h first stretches the skin and then ruptures it, and [illegible] o [illegible] of which thus made a colloidal or mucoid fluid [illegible]pes, is probably a colloid tumor.

15. A tumor which originated in the breast, that becomes complicated with a red or white, brawny, œdematous or tuberculated condition of skin over the growth is without doubt cancerous and of the worst type.

16. The absence of any enlargement of the axillary, or clavicular lymphatic glands with any breast tumor is an argument in favor of its benignancy, whereas the presence of such a complication suggests the reverse. Enlarged lymphatic glands may, however, be found associated with simple tumors when any local sources of irritation arise, and they may be absent for months, years, or altogether in certain examples of cancer, particularly of the atrophic variety in which the disease spreads slowly, and shows no sign of activity. In a case now under my observation of scirrhous cancer of fourteen years' standing, the lymphatic glands are uninvolved.

17. Discharge from the nipple when free is more than suggestive of a duct cyst; where the discharge is serous, of simple serous disease; where blood-stained or blood, of cystic disease complicated with intracystic growth, either of a simple or cancerous nature.

18. A slight sanguineous discharge from the nipple in the absence of nipple trouble, is suggestive of glandular cancerous disease, since simple non-cystic benign tumors never give rise to a discharge from the nipple unless associated with some degenerative cystic disease of the gland.

19. A slow-growing, almost painless, nodular, elastic tumor of the breast, over which the skin is thinly stretched before it becomes infiltrated and later on ruptured, and which discharges a tenacious mucoid fluid, more or less blood-stained, is certainly a colloid.

CHAPTER XIX.

ON MORBID CONDITIONS OF THE NIPPLE.

THE surgeon should in all affections of the breast be well alive to the fact that the nipple may be congenitally deficient, small, flattened out, or not prominent as it is normally. He should remember that a naturally well-formed nipple may have become deformed, or retracted from some inflammatory condition which occurred in early life, or followed a pregnancy which took place long before the complaint for which he may have been consulted appeared. He should know, moreover, that the nipple may have been destroyed by ulceration of a simple or malignant form, or that it may have sloughed off from some inflammatory trouble. He should, likewise, have clearly in his mind the fact that a nipple may have become flattened out or retracted from the growth of a simple benign tumor or cyst situated in the centre of the gland, and he should not jump to the too common conclusion when he finds a retracted nipple associated with a neoplasm, that the new growth is a cancer. A retracted nipple when associated with certain other morbid conditions is a valuable symptom of scirrhus, whereas by itself it has no significance.

There can be little doubt that as a positive indication of cancerous disease, the importance of a retracted nipple has been considerably overrated; and that, although the symptom may be common in infiltrating cancer of the breast, such a disease may exist without it. It may be present, moreover, in simple non-cancerous affections. A retracted nipple may be regarded as an accidental symptom in the development of a tumor, and also as the product of mechanical causes; its presence being determined rather by the manner in which the gland is involved than by the nature of the disease. If any tumor, cystic or solid, simple or malignant, any abscess, chronic or acute, attack the centre of the mammary gland, a retracted nipple

in all probability will be produced; for as a disease so placed necessarily causes material separation of the gland ducts, their extremities, terminating in the nipple, will be drawn upon, and, as a consequence, a retracted nipple must follow. We thus find this symptom of frequent occurrence in the early stage of an infiltrating cancer of the organ, the nipple being always drawn toward the side of the gland which may be involved; while at a later stage, when the infiltration is more complete, the nipple may again project. In a central chronic abscess of the breast, in a case of cyst or of adeno-fibroma or sarcoma, the retracted nipple is equally common, and in the true cystic adenocele it may be also present. In the ordinary adeno-fibroma or sarcoma, whether cystic or otherwise, it is rarely met with, for the reason that this disease is not of the breast gland itself, but only situated in its neighborhood. In exceptional cases, however, such an association may coexist. In one case in which I observed it, a blow or injury had preceded the development of the adenoid tumor, and it was open to a doubt whether the retracted nipple had not been brought about by some chronic inflammatory condition. It should always be remembered, moreover, that a contracted nipple may be a natural condition.

A discharge from the nipple should always attract attention. When the discharge is slight or of a bloody nature, it does not indicate any special affection, though it is well known that in cancerous affections a discharge from the nipple is not infrequent, the fluid having the appearance of blood-colored serum, which is never profuse, and rarely amounts to more than a few drops. In the true cystic affection this symptom is of considerable value, for in the majority of the cases which have passed under my observation, as well as in the recorded examples, this discharge from the nipple was a prominent feature, the fluid being generally of a mucoid nature, and more or less blood-stained; and although at times it occurred spontaneously and with relief to the patient, at others it could readily be induced by some slight pressure upon the parts. In the ordinary solid forms of adeno-fibromata or sarcomata, this symptom is seldom present. It exists, therefore, as a symptom in the true cystic disease of the breast structure, whether cancerous or sarcomatous; and is consequently, as a means of diagnosis, of some value.

"The fluids," wrote Birkett, "which sometimes ooze from the nipple at the commencement or during the progress of a new growth, may be rendered subservient to the formation of a correct diagnostication of the nature of the disease in the part. Sanious, offensive, opaque discharge containing cells, identical with those forming growths of cancer, may be regarded as indicative that the induration which would probably accompany the exudation of such fluid arises from infiltrating carcinoma; while a bright-yellow, clear, tenacious, serous fluid, drawing out into thread-like processes, and the flow of which is perhaps increased by compression on a circumscribed collection of fluid, would guide the surgeon to an accurate opinion that the tumor depended upon the presence of an adenoid growth, or a simple cyst."[43]

Inflammation and ulceration of the nipples is a serious trouble, since it is too often the precursor of mammary abscess. It is more likely to occur in first than in later pregnancies, but if women become feeble at the second, third, or fourth pregnancy, this affection may appear, although they may have escaped the trouble on former occasions. At times the affection shows itself as an inflammation of the nipple and its areola, with all the local phenomena of inflammation or swelling, redness, heat, and pain. In a certain number of cases the inflammation will subside under treatment, and the parts recover their normal condition.

In the majority of cases some local ulceration follows, and this may show itself either as a local "fissure," "chap," or "excoriation," or as a superficial or deep ulcer. In exceptional cases the nipple may be entirely destroyed. The ulcers are generally found between the rugæ or about the base of the nipple. In the worst cases the areola is likewise involved. The ulcerated surfaces are always painful and generally bleed. When the process of suckling is attempted the pain becomes agonizing, and the hemorrhage more abundant. That the pain should be severe under these circumstances can be readily understood. With these local symptoms there is usually much constitutional disturbance.

It has been assorted that these ulcers are commonly caused by some aphthous condition of the child's mouth; I believe they may be so in some cases, but in the majority they result from some unusual sensibility of the skin of the part, and at

times from want of care. In first pregnancies the nipples should always be well looked to, and kept scrupulously clean, and if tender they should be bathed with some mild spirit lotion, or eau-de-Cologne and water, and well protected from friction of the dress by cotton wool or some glass or gutta-percha shield. These shields help to make the nipples more prominent, and at the same time consequently prepare them for their function.

Where ulceration exists, soothing applications are the most valuable, such as Peruvian balsam, castor oil, or almond oil. At times glycerin is of use, while at others it causes pain.

When sore nipples occur at the time of suckling, shields should be worn. Great care should be observed to dry the nipples after the use of shields, and never to leave the shields in the child's mouth after the suckling has been completed. The application of the glycerin of tannic acid, Richardson's styptic colloid, tincture of catechu, a solution of nitrate of silver (gr. v. to the ounce of water), or an ointment of extract of rhatany (gr. viij. to ʒ ij. of the oil of theobroma), are good applications. The summit of the nipple, whence the milk flows, should never be touched with the application. Whatever applications are used they should be washed off before the child suckles. In a few cases I have advised the use of a five-per-cent solution of cocaine before suckling, with great advantage. When cracks exist, it is a good plain for the mother to draw out the nipple by means of the old-fashioned feeding bottle before giving it to the infant, the mother's nipple being put into the central opening, and her mouth drawing the artificial one. Another ready method is the application to the nipple of the mouth of a wide-necked empty bottle that has been heated by hot water, the nipple, as the bottle cools, being pressed into the bottle and rendered prominent in a painless way. All breast pumps are to be condemned.

Eczema of the nipple and areola, or of the latter alone, is a form of dermatitis which must be recognized. It may appear as an eczema in other parts of the body, and get well by local treatment; or persist, become chronic, and eventually take on the form of what Velpeau described as "eczema rubrum," and pass into Paget's disease of the nipple, the precursor of cancer, to which attention has been already drawn.

This eczema may attack single or married women, young

or old; the more chronic variety is generally met with in the latter. It is rarely confined to the areola, but spreads to surrounding parts; it often attacks both breasts.

It is best treated by alkaline soothing applications, such as a lotion of the bicarbonate or borate of soda, five grains to the ounce, with some extract of opium, to get off the scabs, and then an ointment of zinc or lead, separate or combined, or one of soda bicarbonate, ten grains to the ounce, or of boracic acid. In the acute stage, simple lead and opium lotion is the best. Alkalies with some vegetable bitter form the best internal medicine, but tonics and alteratives are often required. The diet must always be simple, and little or no stimulants are, as a rule, required.

When the disease has spread to the end of the nipple, and reached the orifices of the ducts of the gland, it may creep into them, and it is possible that in this way epithelioma may arise; but this question has already been discussed.

Follicular abscess of the areola is by no means uncommon; it may occur alone or in association with an eczematous or other form of dermatitis; it is to be treated as any other follicular inflammation, and usually soon runs its course and gets well.

Ellen D., aged 37, the mother of four children, the youngest being eight years old, came to me in June, 1865, with suppuration of many of the follicles of the areola of her right breast. The disease had existed for eleven weeks. By the use of lead and opium lotion and tonics, recovery took place.

Sebaceous Tumors of the Areola.—These occasionally occur, and may give trouble if not recognized. I have the notes of three such cases that came under my care when out-patient surgeon at Guy's, and they all occurred in young women; they may, however, be found in women of maturer age.

The cases are as follows:

CASE I.—On December 1st, 1867, Mary G., aged 32, came under my care with a well-marked sebaceous tumor in the areola of her right breast. It has been coming for months. I turned it out of its bed as a whole by pressure through an incision, and the case did well.

CASE II.—On June 13th, 1863, Susan D., aged 42, applied to

me at Guy's Hospital, for a tumor hanging from the areola of the left nipple. It was pedunculated, and the size of a small nut. It had existed for three and a half years. When removed it turned out to be of a sebaceous kind.

CASE III.—Mary C., a married woman, aged 22, came to me on March 5th, 1863, with a sebaceous tumor, the size of a nut, above and in contact with the nipple, which had been growing for five months. It had commenced during suckling. I removed the growth by turning it out of its bed. It was clearly sebaceous.

CASE IV.—Charlotte S., aged 24, the mother of one child, consulted me on May 30th, 1867, for an ulcerating sebaceous tumor on the margin of the areola of the right breast, which she had observed ten weeks. I enucleated the tumor, and the patient rapidly recovered.

These tumors may become the seat of cancer. I remember an example of epithelial cancer of the areola of a breast of a middle-aged woman, which followed a tumor which had existed for years, and broke down. I believed the case at the time to have been one of fungating sebaceous cyst; the interior of the cyst on its being emptied having become the seat of epithelial cancer in the same way as is well-known "wens" upon the head or sebaceous cysts on other parts of the body occasionally do.

Growths upon the Nipple and Areola.—Warty, papillary, pedunculated, fibro-cellular, or other growths may be found upon the nipple, which will be recognized by their ordinary appearances. I have seen many such, and give the particulars of two of the cases, the notes of which I have preserved.

These growths should always be removed. In the Guy's museum there is preparation (2,300[60]) of a pedunculated papillomatous growth, the size of a nut, which was attached to the nipple of a woman, aged 48 (Fig. 13). It had been growing for twenty-six years, and during that time she had had ten children, all of whom she had suckled. Mr. Howse removed it.

CASE I.—Pedunculated fibro-cellular growth on the apex of the nipple the size of a nut.

This was met with in the person of Annie S., aged 27, a single woman, about to be married, who came to me in May,

1864. It had been growing two years, and was clearly of the softer kind of fibro-cellular growths. I removed the growth with a pair of scissors, and a good result followed.

CASE II.—Pedunculated growth the size of half a nipple growing from the lower border of the areola of the nipple.

Susan D., aged 42, came before me on June 18th, 1863, with a pedunculated growth connected with the areola of her left breast, three-quarters of an inch long. It was firm to the ıch, and apparently fibrous in texture. It had been growıng for four years. She would not have it removed.

In the museum of the College of Surgeons (Prep. 4,819[A]) there is a specimen of a pedunculated papillary tumor, nearly

FIG. 13.—Pedunculated Papilloma of the Nipple.

one inch and a half in length, which is smooth, firm, and lobulated. Microscopically the growth was composed of overgrown fibrous tissue; but sections taken at its attachment showed an ingrowth of small well-defined epithelium, not like those of epithelioma. The growth was removed by Mr. J. Hutchinson from a woman aged 38.

In the same museum there is likewise a preparation presented by myself of an extremely atrophied breast only two and a half inches in diameter, of which the nipple is enlarged by a growth of dense fibrous tissue, both within and beneath it, and is pyramidal in shape. The other parts of the gland are of firm fibrous texture, but are less dense than the nipple. With the microscope, only fibrous tissue and a few compressed

atrophied ducts, and no cancerous growth, could be found. It was removed from an elderly lady.

Chancre of the nipple is an affection which must not be left out of mind when the surgeon is consulted for an ulcer of the part. I have seen several examples of the kind, with the most typical chancres, infecting and non-infecting. A chancre upon this tissue presents much the same local appearance as upon the external part of the male prepuce. It is to be treated in the same way.

The subject is mentioned here in order that the student and practitioner may be reminded of the possibility of the nipple being the seat of primary syphilis, the mere recollection of which renders the accurate diagnosis of a case more probable.

CHAPTER XX.

ON THE PRESENCE OF MORE THAN ONE NEOPLASM IN THE SAME SUBJECT, AND ON THE SHRINKAGE OF TUMORS.

It is not common to find in the same subject more than one kind of neoplasm, or to meet with cases of cancer having apparently more than one centre. I have, however, the notes of a few such cases, in which the breast, with other parts, has been involved. I quote them simply as curiosities, and as material for future study, and not as texts for speculative opinions.

The first case is a very remarkable one:

Case I.—Rapidly growing sarcoma of right breast, associated with atrophic scirrhus of the left breast of twenty years' growth, and lipoma of the side; recurrence of sarcoma, and repeated operations, in a lady, now 68 years of age.

Mrs. T., aged 64, a very healthy-looking woman, consulted me in 1882 for an ovoid, smooth, semi-elastic tumor, the size of a cocoanut, which occupied the position of her right breast. She was the mother of three children, all of whom she nursed with the left breast, but not with the right, as it was hard and gave no milk. The tumor had been growing for about eight months, slowly at first, but rapidly for the last three months. The breast was lost in the tumor; and the skin and nipple, though healthy, were stretched; there was no enlargement of the axillary glands. The tumor was fleshy and elastic, with a smooth outline. It moved with the breast upon the parts beneath. I regarded it as a sarcoma. In the left, or opposite breast, was a typical atrophic carcinomatous tumor, which had existed for sixteen years. The breast was contracted up into a stony mass; the skin over it was puckered, but not infiltrated, and was adherent to the breast gland; the nipple had retracted deeply into the breast. The left axillary glands

were not found to be enlarged. The carcinomatous tumor gave no trouble, nor was it the seat of pain.

Over the left hip there was a lipoma, the size of a fist, of twenty-five years' growth. This was disregarded by the patient.

On January 9th, 1883, I removed the tumor with the right breast. The tumor was succulent, and on section showed a homogeneous structure; a glairy fluid exuded from its surface, which was of a pinkish-gray color. Under the microscope the tumor was made up of spindle and round cells, with but little fibre tissue.

The case did well after the operation, but a return in the neighborhood of the scar soon took place, for which another operation was demanded. This in its turn was followed by a speedy convalescence, and again by the return of the growth. Up to the present time, July, 1887, four and a half years after the first operation, sixteen operations have been performed, and the patient's general condition is excellent. Repair follows each operation in a most satisfactory way, and beyond the necessary trouble connected with an operation, the general health of the patient suffers in no way. Neither the carcinoma of the breast nor the lipoma has made any progress.

The dates of the sixteen subsequent operations are as follows: July 19th, Oct. 24th, 1883; April 2d, July 2d, Oct. 8th, 1884; Jan. 16th, June 20th, August 13th, Oct. 29th, 1885; Feb. 10th, April 28th, July 17th, Oct. 9th, 1886; Feb. 9th, April 13th, July 6th, 1887. Sometimes one growth has been removed, at others several. Every growth has had a delicate capsule, and each one has been readily enucleated. Some have been in the fatty tissue of the part, others have been in muscle; some have been in glands.

The specimen removed on April 2d, 1884, was examined by Dr. Goodhart, who reported the "growth is a mixed sarcoma, chiefly a spindle-cell sarcoma, but there are some myxoma-like cells in several places."

Mr. Symonds examined the tumor removed on July 2d, 1884, and reported as follows:

"The tumor was oval, measuring 1½ in. by ¾ in., perfectly smooth in outline, and covered by a thin capsule. No breast or other tissue was attached to it. It was soft and elastic, of a gray color, and showed an almost uniformly homogeneous

section. It could easily be broken down by pressure, but at two points was somewhat more resistant. The surface when scraped yielded a thin gelatinous fluid, containing cells of various shapes, the majority were oval, with several nuclei, and many were spindle-shaped. The nucleus of the latter closely resembled the former cell. There were also a few round cells.

Microscopically the harder parts showed interlacing tracts of spindle-cells, cut in various places, giving the alveolated appearance common to such tumors. The vessels were numerous, the arteries having well-defined walls, while the veins appeared as spaces in the tissue, and being in places collected in groups, gave a cavernous aspect to this part of the section. In the softer parts the vessels were more numerous but smaller, the cells also smaller and more of them round, the whole having the appearance of granulation tissue. The typical cell was a spindle, with a large oval granular nucleus. The spaces referred to above as venous were of various shapes, and suggested, from their arrangement, that they communicated. Their walls were very thin, and showed elongated nuclei in a small amount of imperfect fibrous tissue, but, as stated above, appeared more as spaces in the growth. Though this is the common structure of veins in new growths, the arrangement in groups or plexuses seemed to call for special mention, as the spaces might be mistaken for cysts. Their resemblance to the singly placed apertures, and the absence of any epithelial lining, confirms the interpretation here given.

Mr. Eve, of the College of Surgeons, examined the tumor removed on February 10th, 1886, and reported that it consists entirely of round cells in mucous tissue. "Probably," he adds, the original growth belonged to the class of tumors formerly known as recurrent fibroids. The elements get more elemental with each recurrence as a rule." In this matter Mr. Eve is doubtless correct.

It is a point of great interest to find in a woman, now 68 years of age, a most active growing and recurring sarcoma, side by side with an indolent atrophic carcinoma, and with her general health perfect. It is likewise worthy of note that in this case, as in Cases II. and XXIV., recorded in the chapter on cystic sarcoma, the disease attacked glands that had failed to secrete milk.

CASE II.—Carcinoma of the breast, one year; lipomata of groins thirty years.

Caroline B., aged 57, the mother of one child, came to me on February 21st, 1867, with a scirrhous infiltration of her right breast and adherent skin over the tumor, which was fixed to the parts beneath. The axillary lymphatic glands were likewise enlarged. The disease had been discovered one year. Two large pendulous lipomata, the size of cocoanuts, also existed in the groins, which had been growing for thirty years.

CASE III.—Carcinoma associated with an adeno-fibroma of the right breast; amputation of breast.

Eliza C., a single woman, aged 49, came under my care in May, 1885, with a tumor in her right breast, which had been growing for about three years. When seen the lower and axillary lobes of the right breast were evidently infiltrated with some new material, and the swelling formed a tumor three inches in diameter. It was hard and nodular to the touch, and moved with the breast upon the parts beneath. The nipple was natural, skin dimpled; the axillary glands were not felt to be enlarged.

On June 6th the breast was removed, and on exploring the axilla some lymphatic glands were found enlarged and taken away. The patient did well, and left the hospital in one month.

On making a section of the tumor, one-third of the gland was the seat of a true scirrhus, and the gland tissue about it was the subject of cystic degeneration. Between the cancerous tumor and the nipple, and upon the surface of the gland, there was a second tumor, the size of a nut, which was encapsuled, and on section presented a coarse lobulated surface, and to the eye and microscope yielded the appearance of an adeno-fibroma. In the Museum of the College of Surgeons a specimen of a like kind has been placed by Mr. J. Hutchinson.

CASE IV.—Carcinoma of the breast following epithelioma of the nose.

Jane B., aged 63, a childless married woman, came under my care in 1861, with epithelial cancer of one nostril. This I removed, and a good recovery took place. Five years later, that is on June 25th, 1866, when she was 68 years of age, she came to me with a hard infiltrating carcinoma of her right breast, associated with a puckering of the skin over the breast, which had been coming for eight months. The disease pro-

gressed very slowly; one year later tubercles appeared in the skin over the breast, and the axillary glands became enlarged; six months later the arm was œdematous, and she died toward the end of 1868.

Case V.—Carcinoma of the breast of twenty-five years' growth, followed by epithelial cancer of the nose.

Frances H., a widow, aged 72, with one child, came to me on July 1st, 1865, with a marked example of atrophic carcinoma of her right breast of twenty years' standing, which had been ulcerating for seven years.

In February, 1871, that is, six years later, when she was 78 years of age, she came to me again with a marked epithelial cancer of one of her nostrils. The breast trouble, which had then existed for twenty-six years, had altered but little.

Case VI.—Infiltrating carcinoma of breast, and ulceration of the nipple; preceded by discharge from nipple associated with cancerous stricture of the œsophagus.

Mrs. G., a thin feeble woman, aged 60, came under my care on February 25th, 1885, with a central hard tumor infiltrating the whole of the left breast, and a raw red ulcer occupying the position of the areola and nipple, and enlarged axillary and lymphatic glands. The nipple had entirely disappeared by ulceration. She was the mother of two children, the youngest being 25, both of whom she suckled without trouble. For eight or nine years previously she had had a watery discharge from the nipple, and nine months later the discharge was bloody. Two years ago the nipple became sore, and this soreness spread; about this time a lump appeared in the centre of the breast.

As the soreness of the nipple spread, the nipple steadily disappeared, and the tumor of the breast increased.

For five years she had had steadily increasing difficulty in deglutition, and for some months had only been able to take milk with sopped bread. The smallest size bougie can be passed through a strictured œsophagus.

As no active treatment was possible, I did not see this patient again.

Case VII.—Lymph-adenoma of cervical glands, followed by acute brawny cancer of the breast, and subsidence of the swelling in the lymphatic glands.

Sarah B., aged 49, a childless married woman, came under

my care in 1875, with enormous enlargement of the lymphatic glands in both sides of her neck, and behind and beneath the jaw. The swellings were composed of tumors the size of eggs, which could be moved about beneath the skin. These glandular swellings had been gradually coming for fifteen years. The woman was feeble and leucæmic.

Four years later this woman came to me again with a brawny carcinoma of her left breast, which had commenced four years before as a small lump, which grew slowly, and steadily involved the gland as a whole. When seen, the breast was generally infiltrated and hard. The skin covering it was adherent to the breast and felt like brawn; it had, moreover, in different parts many distinct indurated cancerous tubercles. The lymphatic axillary glands were enlarged.

Oddly enough, however, from the first appearance of her breast trouble, the cervical lymph-adenoma steadily subsided, so that when coming under observation but very slight enlargement of the glands could be made out.

The woman had a red complexion and a watery eye, but her urine was natural. Her powers were feeble, and I learned later on that she sank from what was supposed to be internal cancer.

The association of these two diseases is very interesting, and the fact that the lymph-adenoma diminished as the carcinoma increased is remarable.

On March 6th, 1874, I was present when my colleague, Mr. Durham, removed from the buttock of a woman, aged 65, an epithelial cancer the size of a florin, from whom Mr. Hilton had excised, twenty-three years previously, the right breast for cancer, and the scar was then a good one.

On the same day Dr. S. K. Fowle, of New York, who was visiting London, told me that in 1858 he saw the late Dr. Gross remove from the cicatrix of an operation in the breast of an old woman a carcinomatous tumor, the size of a walnut, of one year's growth; Sir A. Cooper having excised the woman's breast thirty years before for cancer.

I would also here draw attention to the case of colloid tumor of the breast, published at page 198, in which the removal of a colloid growth in the breast was, eight years later, followed by a typical scirrhous carcinoma of the opposite breast.

CASE VIII.—Carcinoma of the left breast; excision; return in the scar nine years later; four years after removal of breast, the appearance of a melanotic sarcoma in a mole situated in the left axilla; excision and no return; uterine cancer eight years after the removal of the breast; and carcinoma of the left femur, fracture of bone, and death nine years after removal of the breast.

Mrs. K., aged 50, the mother of seven children, all of whom she had suckled without difficulty, the youngest being sixteen years of age, consulted me in May, 1876, with an infiltrating carcinoma of her left breast, which had been slowly growing for two years. The nipple was retracted, and the skin about the nipple infiltrated. No axillary glands were enlarged.

On May 3d, 1876, the breast was removed, and a rapid recovery followed. The axilla was not explored, as nothing could be felt through the thin integument. Four years after the operation in her breast, a mole, which had existed in her left axilla, on the side from which the carcinoma had been removed, became the seat of a melanotic sarcoma. After six months' growth, when it had attained the size of a nut, I took this away and no return took place.

In 1884, eight years after the operation on her breast, the neck of the uterus became the seat of cancer; the disease appeared as a nodule the size of a hazelnut, and from this there was at times free bleeding.

About this time the left arm became œdematous and painful. In December of 1884 she complained of pain and stiffness in the upper part of her left thigh, which soon became swollen, and before many weeks had passed it was evident that the upper part of the femur was enlarged. In June, 1885, some carcinomatous tubercles appeared in the scar of the breast operation, and when getting into bed she felt something give way in her thigh, and heard a crack. Dr. Curgenven, her medical man, saw her, and discovered a fracture at the seat of the swelling, and there can be no doubt as to the swelling being a cancerous tumor.

From this time she steadily sank, and died in August, 1885, nine years after the removal of a carcinoma of the breast, and five years after the excision of a melanotic sarcoma of the axilla.

CASE IX.—Melanotic sarcoma originating in a mole situ-

ated in the right axilla, followed in four years by an infiltrating carcinoma of the right breast.

Mary P., aged 40, a single healthy woman, came to me in April, 1872, with an ulcerating melanotic sarcomatous growth, the size of an orange, which had originated two years previously in a mole in the right axilla. No enlarged lymphatic glands were to be felt. On April 25th I excised the growth, and a good recovery followed. The patient remained well for nearly four years, when the breast of the same side became painful and enlarged, and six months later, when she came to me for advice, the breast was evidently the seat of an infiltrating carcinoma. The scar of the operation for melanotic sarcoma was sound, and no signs of recurrence were present. In July, 1876, I removed her breast, which on section was clearly of a carcinomatous nature, and a good recovery ensued. In 1884, eight years after the removal of her breast, and twelve years after the excision of the sarcoma, this patient was known to be quite well.

Shrinkage of Tumors.—Adeno-sarcomatous and fibromatous tumors, in very exceptional occasions, diminish in size by time. I have certainly seen two examples of the kind and am disposed to think that the diminution in the size of the growth is to be explained by the absorption of such fluid as might have filled the growth or its capsule, rather than to any true shrinking of the neoplasm itself. Explain the matter how we will, the fact must, however, be recognized.

The cases are as follows:

Case X.—Adenomata in the breast of a suckling woman, which diminished in size subsequently.

Eliza F., aged 22, a married woman, pregnant four months, came to me on March 15th, 1868, with an adenomatous tumor, the size of half a cocoanut, in the axillary border of her left breast, and a second the size of an orange in the sternal border of the same gland. The two had been growing steadily for two years. During the progress of the pregnancy both these tumors grew rapidly, and became at last twice the size they were.

On September 30th she was confined, and suckled with her right, or unaffected breast, for three months. The tumors in the

left still grew. After weaning they, however, steadily diminished, so that on January 3d, 1870, that is, twelve months later, they had returned to the size described when seen in March, 1868.

It should be added that this patient's single sister, when 21 years of age, came to me in June, 1870, with great enlargement of her left breast, from supposed hypertrophy. The gland was twice the size of the right breast.

CASE XI.—Adenoma of the breast of eighteen years' growth diminished by time.

Margaret K., aged 41, a single woman, came under my care on July 3d, 1873, with a tumor in her left breast of eighteen years' standing, which was the size of an egg, soft, lobulated, and movable in and with the breast. It was quite painless. Eight years previously the tumor had been more than twice its present size. It had grown steadily for two years, when growth stopped and changed into shrinkage.

CHAPTER XXI.

NÆVI AND VASCULAR TUMORS OF THE BREAST—LIPOMATA AND CHONDROMATA OF BREAST.

NÆVI are found in the skin covering the breast, in the same way as they are found in other parts of the body. In rare cases they may be found upon the nipple. I saw an example of this many years ago in a female child, who had a red, raised, florid nævus, the size of a shilling, situated upon the breast and half the nipple. I destroyed it by means of the galvanic cautery, after two or three applications.

Conrad Langenbeck has recorded cases of nævi which have extended from the skin to the breast beneath. Such cases in infants must be difficult to diagnose, since the breast as a gland is but rudimentary, and even when the nævus involves the deeper tissues, it may be a question as to how far the breast may be involved.

That the breast may be the seat of true nævoid disease there is no doubt, although such cases must be rare. I cannot find any examples recorded, beyond the one I have briefly alluded to in my work on the practice of surgery. In that case the breast, with the skin over it, was one vascular half globe. It was spongy to the hand, and could be emptied by pressure and easily refilled. The nipple was apparently retracted, but this condition was brought about by the elevation of the parts about it. The notes of the case as taken at that time are as follows:

CASE I.—Nævus involving the whole of the breast.

Mary R., fifteen weeks old, was brought to me at Guy's Hospital on October 14th, 1869, with a nævus involving the whole of the breast gland and skin over it; the nipple was retracted. The tumor measured two inches in diameter, and was like half a globe; it was spongy to the feel and prominent. Large veins converged toward its surface and through the skin. At

the margin of the gland the purple substance of the nævoid structure was visible. The whole swelling could easily be reduced by pressure, and on the removal of which the swelling returned. No treatment was adopted.

Lipomata of the Breast.—That lipomatous tumors may be found in the integument that covers the breast, that is, in the paramammary tissue, the experience of most surgeons will prove, although it is not so clear that they are met with within the gland structure or behind it. Gross says, "I am not aware of a single case of circumscribed lipoma occurring in the gland itself," and if he means by this a fatty tumor unconnected with the surrounding fatty tissue he is probably right, and his experience most certainly coincides with my own.

Sir A. Cooper, in 1805, removed the breast of a woman which measured in circumference thirty-one inches, with a large lipomatous tumor, which was subsequently found to be situated behind the gland, and to have weighed 14 lbs. 10 oz.

He also removed from a woman who had a breast of great size, by a single incision, masses of fatty tissue from between the different portions of the gland which was itself healthy. "The lobes of fat which are interspersed between the different portions of the mammary gland, and which serve naturally to augment the size of the bosom, having become enlarged and formed a swelling, which, prior to the incision being made, seemed to involve the whole of the breast; but when the operation was performed, the different lobes of adeps which formed the tumor could be drawn away from the gland itself."

In the Guy's Hospital Museum (Prep. 2300[50]) there is preserved "a large adipose tumor, which measured 23 inches in circumference, and was removed after death from the breast of a married but sterile old woman, aged 87. When 30 years of age she observed the tumor in the upper part of the right breast, and this she showed to Sir A. Cooper on January 9th, 1806. She remembered the date, because it was the day on which Lord Nelson was buried. The growth slowly enlarged, but not during the last few years. It was thought to have been an adenocele, but when a section was made it was found to consist of fat, with a piece of bone in the centre." Fig. 1 on Plate IV. was taken from this patient during life.

A lipomatous tumor may, however, be developed in the tissue covering the breast or elsewhere. The following is an example of the affection:

CASE I.—Lipoma the size of half an orange over the breast; excision; cure.

Annie B., aged 50, came under my care on September 5th, 1883. She had had four children, the youngest being eleven years old. Five years ago she noticed a lump in the upper part of her left breast, which has steadily increased. When seen the lump was the size of half an orange, and measured three by two and a half inches. It was placed over the clavicular lobes of the left breast, and was movable over the gland. It was clearly lobulated and apparently fatty. On September 7th I excised it and found it to be a pure lipoma. The case did well.

Chondromata.—These growths are rarely met with in the breast. Sir A. Cooper gives one case, with a drawing, in his work on the breast; he removed it from a healthy woman, aged 32, and it was of fourteen years' growth. The pain in it was very severe, and the tumor was excessively hard. He removed the growth, and the larger portion of it had the ap pearance of that cartilage which supplies the place of bone in young subjects. The remaining portion was ossific. Fig. 2 on Plate IV. illustrates the case.

Professors J. Müller, Rindfleisch, and Billroth, record other cases in which nodules of cartilage were found in the breast. In the Guy's Museum, Prep. 2316[50], there is a tumor which was taken from the breast of a middle-aged woman. It was examined by Dr. Wilks, who pronounced it to be fibro-cartilaginous.

In vol. xxxiii. of the Pathological Society's Transactions of London (p. 306), Mr. Bowlby reports a case of chondro-sarcoma of the breast, of one year's growth, taken from a woman, aged 42. The breast with the tumor, which was encapsuled, was removed, but a return took place which proved fatal within six months of the operation.

Cruveilhier has also described a case in vol. iii. of his "Anatomie Pathologique," but Mr. Bowlby throws some doubt about its true nature. Upon the whole, although it must be accepted as a fact that the disease may occur in the

breast, it is certainly very rare. It may occur as an innocent growth or in association with a malignant one.

On May 18th, 1886, Mr. W. H. Battle showed the members of the London Pathological Society a specimen of osteo-chondrosarcoma of the breast, which is very rare.

It was taken from the right breast of a widow, aged 73, who had had five children. The tumor commenced as a hard lump, to the inner side of the nipple, six years before. The growth was painless, and the patient's general health unaffected. It grew slowly until, within a year of its removal, it had attained the size of a large orange; it consisted of two portions, an inner, very hard and rounded, about the size of a walnut, which the patient had noticed for a long time; and an outer, a more recent development, more elastic, of the size of a large egg. The nipple was much retracted. The skin was adherent, red, and tense at the inner part. One small freely-movable gland was detected in the axilla. The growth consisted of a large portion composed of a soft, friable, extremely vascular material in which there had been numerous hemorrhages; and of a smaller very hard portion which resembled bone, and could not be cut with a knife. Microscopic examination of the tumor showed it to consist, in the softer parts, of round and spindle cells; and in the harder, of cartilage which had in parts become ossified, the section showing well-marked Haversian canals.

CHAPTER XXII.

TUMORS OF THE MALE BREAST.

THE male breast is liable to the same affections as the female, but in a far lesser degree; the male gland at no period of its life being called upon to show any functional activity.

It may, in infancy, be as frequently the seat of inflammation as the female gland, and in a former chapter it has been shown to be liable about puberty to a marked growth, and to a spurious functional activity, which may lead up to inflammation. It may also, as a result of injury, be the seat of abscess.

Fibromata, sarcomata, and adenomata have been met with in the gland, and carcinomatous tumors are not rare. Thus Mr. W. R. Williams reports that out of about 280 examples of adenomata of the breast, consecutively noticed in London hospitals, one was in a male; of 68 examples of sarcomata of the breast, two were in males; and of 1,433 cases of cancer of the breast, fourteen were in males; or roughly speaking, that one case of benign tumor of the breast is met with in the male to 116 in the female; and one case of carcinoma in the male to 102 in the female; carcinoma in the female being at least a hundred times as common.

These averages are doubtless quite reliable, since they have been calculated from the combined experience of four large London hospitals, during ten, twelve, and seventeen years. They differ from smaller statistics published by Sir J. Paget, who believes that two cases of scirrhus of the breast occur in men to 98 in women; by Gross, who has seen two examples in males to 100 in females; by Billroth, who gives seven cases in males out of 252 cases; or taking all these cases together, in the proportion of one to forty-two.

Wagstaffe gives, in vol. xxvii. of the Pathological Society's Transactions (p. 246), a table of sixty-one cases of cancer of

the breast in the male, collected from all sources, from which we learn that in only six of the whole number the disease appeared under the age of 40; in twenty it appeared between the ages of 40 and 60; in seven between the ages of 60 and 70; and in seven in subjects over 70 years of age. The disease has evidently a tendency to occur in old rather than in middle-aged men.

The diagnosis of these cases of neoplasm in the male, as well as their treatment, is to be determined by the same symptoms, signs, and conditions, as those of the female.

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ON THE SURGERY

OF

THE KNEE-JOINT,

AND

The Responsibility placed on the Physician and General Practitioner by the Modern Progress of Surgery.

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ON THE

SURGERY OF THE KNEE-JOINT.

CHAPTER I.

ON THE SURGERY OF THE KNEE-JOINT.

GENTLEMEN:—I propose to contrast the treatment of the principal affections of the knee-joint and its immediate neighborhood as practised at the present day with that in favor with the leading surgeons ten years ago.

The knee is a region pre-eminently fitted to be chosen for such a contrast. It is so superficial that the alterations produced in it by disease are manifest and clearly marked. It is so liable to disease and so exposed to accident that the most youthful and inexperienced surgeon is familiar with it. Its affections are also types of all surgery; not only are chronic pulpy disease of the synovial membrane of the knee and central necrosis of the head of the tibia types of similar affections which attack the other great synovial membranes and epiphyses of the body, but even genu valgum, properly understood, is a key to the comprehension of scoliosis, of flat foot, and of other leading deformities, of which a false pathology, a false etiology, and a misguided treatment are even to this day too frequently taught and practised. Let any one study carefully the facts and opinions on chronic disease of the knee-joint to be found in the handbooks and monographs of ten years ago, and he cannot fail to see that in those days, recent as they are, the rich man with chronic knee-joint disease who submitted to an operation was little better than a fool, while the poor man who was operated on in order to get independence

and the means of earning a living for himself and his family was a hero. In short, ten or twelve years ago, it was the practice, and then the correct practice, founded on the experience of the time, to tell a patient with a diseased knee, if he was no longer quite young, that his choice lay between, on the one hand, immediate amputation of the thigh, and, on the other, a long, tedious process of treatment, very likely involving three, five, or even ten years' incapacity for following his employment, and, as likely as not, ending in amputation after all. He had also to be told that his chances of life and death after amputation were no better than two to one. (Bryant's statistics of 119 amputations in patients between the ages of twenty and forty. See Erichsen, vol. ii., p. 272, date 1877.) If the patient were a child or an adolescent, not very different information could be honestly given. Amputation at that age was comparatively safe, but excision was still very dangerous. Of ninety-seven cases collected by Bryant, twenty-seven died.

Scarcely less serious were the long periods required for treatment after excision. "Roughly speaking, the average duration of treatment (after excision) was about eight months," wrote Holmes; but this is short compared to the period during which the poor patients, almost all belonging to the lower orders, probably required treatment, but did not get it, from sheer weariness on the part of the doctor or the patient, or the parents of the latter, or from the pressure of house-committees.

Now let us turn to the present time. In the first place, it is now, practically speaking, quite safe for a surgeon experienced in such operations to open wide the knee-joint and explore its every crevice; moreover, within two or three months he can expect to see every part of the joint and every muscle acting on it completely restored again. The history of the operation for suture of the patella proves this. It is true that some unfortunate results have occurred and a few fatal ones; but when we remember what a large number of sutures of the patella have been done by surgeons with little or no practical experience of such operations, and many of them quite recent converts to a faith in antiseptic surgery, after being trained to habits absolutely inconsistent with it, and, like all habits, difficult to shake off—when we bear these facts in mind, we should be surprised, not at the occasional failure of the opera-

tion, but at its frequent success. But this is not a mere question of numbers. Look at the quality of the success in most cases of antiseptic suture of the patella, the rapid convalescence, the perfect restoration of function, and the absence of every sign of danger from first to last.

In the matter of operations, a surgeon can speak, after all, only for himself, and for those with whose practice he is personally familiar; it is, therefore, merely a cautious and guarded mode of speaking, and not vain boasting, when I say that I feel less fear now about opening and examining a knee-joint than I felt ten years ago about excising a fatty tumor. Not that I can count excisions of the knee by the dozen, but because for some years I have been week by week acting on the faith I have just declared, and have found in every bone and every joint, and nearly every cavity of the body, my confidence justified. But I never myself commenced to practise in any department of operative surgery without feeling the disadvantages of inexperience, and being, moreover, shown by the course of events what dangers are run by the patient on whom the surgeon tries his 'prentice hand. For instance, my first case of osteotomy suppurated and did no good. In only two instances since has a single drop of pus formed, and in these two the ultimate result was excellent and not long delayed. In fact, let us never forget to distinguish between the dangers of an operation and of the particular operator who does it.

It is no longer necessary for the honest surgeon to tell his patient with diseased knee that to submit to operation is to run a risk as great as that of fighting in a forlorn hope. On the contrary, given a patient free from consumption, not hopelessly exhausted and broken down, and not over forty years of age, I can honestly tell him that I can open his knee-joint and either remove the diseased parts, or excise the joint, or amputate, according to what may be required in his individual case, with no fear of serious risk to life. And the prognosis as regards the quality of the limb, if saved by operation, is also extraordinarily improved.

What was the ordinary result of a successful operation ten years ago? A limb greatly shortened, the foot sometimes nearly on a level with the lower part of the opposite calf, the knee often greatly bowed outward and bent forward, almost

always absolutely stiff, and if movable, weak and unreliable. Now, as to shortening, I will, if all be well, exhibit in the course of the session a series of cases, each a type of a different mode of operating suitable for cases like itself. In only one will you detect marked shortening, and that scarcely enough to be either a disfigurement or an inconvenience. In one of these cases there is excellent mobility, and no weakness therewith. How long were they in hospital after operation? An average of two or three months each. Has any sinus or sign of disease remained? No.

It remains now to indicate how these improved results can be attained. In the first place, it is now recognized that the diseased soft parts, the degenerated synovial membrane, and the infected bursæ require removal as much as do the carious portions of bone. Not a hint of this was to be read, at all events in English works, a dozen years ago. Secondly, healthy bone is, as a rule, left alone. The practice of removing sound bone or cartilage, because they might become diseased if left, should now be scouted as ridiculous, if not monstrous. Whatever healthy bone is taken away is removed for mechanical reasons; *e.g.*, to prepare two surfaces suitable for cohesion when speedy osseous ankylosis is expressly desired, or to give access to concealed parts, or to make a channel for drainage. Thirdly, when disease has spread to the shaft of the bone, the medulla is scraped out, and the surgeon does not go on either slicing away one inch after another of the shaft, or else proceeding to amputation instead of excision.[2] Fourthly, the effect of certain drugs on the diseased parts is known and utilized. Fifthly, the joint is opened in such a way and closed, after operation, by such means as completely restore the joint capsule and the muscles and aponeuroses around it. Sixthly, a better system of drainage has been introduced. Seventhly, dressing and after-treatment have been greatly improved. Eightly, after excision the bones are wired. The diseased soft parts, the pulpy synovial membrane, and so much of the ligaments and bursæ as may be diseased, are carefully cut away with scissors. In many cases these are the very centre and focus of the disease, such bone and cartilage as may suffer being attacked quite secondarily, and sometimes to an insignificant extent—as, for instance, was the case with the young woman whom I will show you, who recovered rapidly and with

a very movable joint. This excision of soft parts has to be done with great care and thoroughness; but it is not necessary to remove absolutely every vestige of disease in order to effect a cure. In this respect tuberculosis of the joints differs markedly from cancer. As a matter of fact, tuberculosis tends to die a natural death. Time will kill local tuberculosis unassisted by the surgeon. The misfortune is that it is so dilatory in the exercise of its healing powers that very often the patient or his joint, or both, are destroyed before the disease, but when vigorously helped by the surgeon, time wakes up as it were. It has been often observed, after excision of a joint, that tuberculous granulations have sprung out, say, from a sinus left by a drainage tube, lived a precarious existence, and then perished spontaneously, or with very little interference from the surgeon. Nevertheless, it is well to operate with the greatest possible care and thoroughness.

Next, with regard to the treatment of healthy bone, it used to be the rule to take away the patella lest it might become diseased. Some surgeons—*e.g.*, P. H. Watson, of Edinburgh—opposed the practice, but they were exceptions. Now, when once the tuberculous foci have been found and thoroughly removed, not an atom of bone should be cut away except to favor drainage, or to make opposed surfaces fit after excision. After a really complete and systematic operation on a tuberculous knee-joint the fear of recurrence is small. And if we are to attempt to abolish it by removing all cancellous bone, in which the return can possibly take place, amputation may as well be done at once. In fact, those surgeons who with these views always amputate and never excise are strictly logical. In children, more bone and articular cartilage have usually to go than in adults. I have several times completely, or almost completely, scraped out the bony part of the epiphyses, always carefully leaving the so-called epiphyseal cartilage, and removing no more of the articular cartilage than was either necessary to give entrance to the sharp spoon, or was itself diseased. The cartilage on those parts of the femoral condyles which actually touch the opposed articular surface should be, as far as possible, left untouched. Any small diseased points in it may be carefully picked out. If both articular and semilunar cartilages are healthy, the latter may be left.

w with regard to drugs. Those best adapted for the . are solutions of sublimate (1 in 1,000), and iodoform ... als. That the latter has a really specific influence on tuberculous *materies morbi* (it is quite unnecessary to enter into the question of whether it is or is not Koch's bacillus) can scarcely be doubted. Always should iodoform crystals be dusted over the surface operated on, and especially in the crevices and recesses of the joint, where there is most danger of portions of infected tissue having been left behind. To place the iodoform in these, the cutting spoon may itself be used, in its capacity as a spoon, not as a cutting instrument. The iodoform should be placed before the Esmarch's ...lage is removed and while the joint is dry. Free sponging douching with the sublimate solution should precede the iodoforming. It is dangerous, expensive, and not necessary to use iodoform extravagantly, and the crystals, as being less quickly and easily absorbed, are safer than the ground ...wder. An ethereal solution of iodoform may be used. It will ...netrate into every crevice and deposit a thin layer of the drug on every surface. But it is irritating to the eyes of the surgeon a... assistants, especially if it has been long kept.

... manner of opening the joint is very important. For a ...orough exploration of the knee-joint a transverse incision is essential, and it must be supplemented by a perpendicular incision to open the synovial pouch, which extends upward beneath the extensor cruris. The transverse incision may divide either the patella itself or the ligamentum patellæ; preferably the former, I think. A strong knife will cut a child's patella, but an adolescent or adult requires a saw. I prefer to divide the patella because (1) it can be so easily, certainly, and perfectly reunited; and (2, a minor and almost superfluous argument) the section shows accurately the condition of the centre of the bone. I doubt whether a sutured ligament is as strong and trustworthy as a sutured bone. Therefore one should, if possible, avoid dividing the lateral ligaments. When divided they should be carefully sutured at the conclusion of the operation. A short supplementary incision may be made anywhere, if required to expose any otherwise inaccessible angle or crevice. In the West London Hospital, some years ago (September 11th, 1883), I introduced a new mode of opening the joint, applicable when it is not infected with

tubercular disease; *e.g.*, when excision is to be done for injury or for orthopedic purposes, and particularly applicable as an exploratory incision in cases of injury to the knee-joint. It consists in a long perpendicular incision through the patella, ligamentum patellæ, and anterior wall of the upper synovial pouch. Ollier, of Lyons, had described and recommended this incision a few months before I did it; but, to the best of my belief, mine was the first case, and I was led to operate thus, certainly not by Ollier's paper, of which I had not then heard, but by the simple intention of obeying one of the first rules of the surgery of the limbs, which is always to prefer a longitudinal incision where it will suffice. The same operation has been recently and independently devised by Mr. Herbert Allingham. I would not, however, employ it for tuberculous disease; it does not, in my opinion, give sufficient view and access for operating thoroughly and minutely.

On the table is a specimen of a knee-joint which I explored in this manner. The condyles were merely bruised. There was a compound fracture just above but not into the joint, as the exploration showed. I drained it for a few days, and if the whole limb had done as well as the joint the specimen would not be here. But the lacerated tendons and skin sloughed so extensively throughout the popliteal space and calf that there was no hope of getting a useful leg, and grave risk of inability to keep aseptic the compound fracture. I therefore amputated the thigh, and the boy did well.

When a patella has been cut in two with a knife or saw, more care is required to fit the segments accurately together than after a fracture. In the latter case they interlock like the pieces of a puzzle. In the former they readily glide, tip, or gape. Catgut does very well for the suture, and in children it can be carried through the cartilaginous patella with a strong needle. When there is prospect of a movable joint, cut aponeuroses should be united with buried catgut sutures. Cut ligaments should always be so treated. The crucial ligaments should be spared if possible, and they can be spared in most of the cases fitted for simple erasion.

Now as to drainage. Special tubes should be inserted into the superior synovial pouch. Generally the centre of the joint is best drained toward the side, the tube lying in a channel gouged for it in the surface of one or other condyle. A special

lateral or postero-lateral opening may be made for it. This main tube should be large, especially if the joint has suppurated before operation. Indeed, in that case the tubes should all be large and permeate every part of the joint and everywhere the abscess may have burrowed. Secondly, one should not be in a hurry to remove these tubes. A fortnight for a case which is aseptic is not too much. And when a case is septic the tubes should be kept in until the knee is either ankylosed or amputated if it cannot be saved. Endless mischief is done by the eagerness of inexperienced people to withdraw drainage tubes.

With the use of sublimated wood-wool or turf-moss pads, and firm bandaging and strapping, aseptic cases will heal under one dressing, but a pedantic desire to obtain this is to be deprecated. If pain or a rise of temperature occur, and cannot be plainly referred to some obvious or removable cause, it is best to dress at once. Recurrent and secondary hemorrhages used to be particularly frequent after excision of the knee. I always bandage the turf-moss or wood-wool pads very firmly down at the first dressing, and the next day relax any uncomfortable pressure by snipping with the scissors, afterward stretching strips of strapping across any gaping interval. Sometimes, especially in children, I do not tie a single artery, but apply the dressings before having the Esmarch's band removed. Since I have used thick sublimated pads of turf-moss or wood-wool I have never been troubled with hemorrhage. They should be bandaged on very firmly and evenly, and the limb kept much elevated for the first twenty-four hours. Some surgeons do not use Esmarch's bandage for fear of troublesome recurrent hemorrhage after it. No such fear need be felt when the value of such a mode of dressing and elevating as that just described is properly appreciated. I have seen great and even dangerous shock after excision of the knee without the use of the bandage. The more I see of operative surgery, the more am I convinced that so-called shock is generally due almost entirely to loss of blood, or, at all events, that most of what is serious and dangerous in shock is due to hemorrhage. Another cause of shock is a long operation and its necessary accompaniment, prolongation of the anæsthesia. With a bloodless limb, one can operate faster, and, at the same time, better.

One of the greatest essentials of after-treatment is perfect, continuous, undisturbed fixation. Nothing secures this so well as plaster-of-Paris. But its universal use is very wasteful of the surgeon's time, which is no more an inexhaustible quantity in a civil hospital than on the field of battle. I have therefore sometimes put up fresh excisions with movable splints for the first fortnight, by which time the wound is usually almost healed and the discharge has ceased, so that a small, thin, antiseptic dressing suffices. Over this a plaster-of-Paris case fits much better and more effectively than over a large turf-moss or wood-wool pad. During the first fortnight a weight extension may be found comfortable and satisfactory after erasion. It would be out of place in excision cases, on account of the wires with which the bones should always be fixed together. Many surgeons prefer nails or screws to wires. I do not think anything can be simpler or handier or more effective than wires. Two are required, one on each side. They can be either buried permanently or arranged for removal. In the latter case they should be left for two months. Perfect osseous ankylosis must not be reckoned on under several months after any form of operation, not even when plaster-of-Paris is used continuously.

If it is asked to whom all the alterations—improvements, I hope—above noticed are due, it becomes difficult to do justice to the West London Hospital and to others at the same time. Primarily they are the logical outcome of a belief in antiseptic surgery and of the application of a variety of means due to different inventors, not the least important being Esmarch's bandage and the sublimated pads brought here from Germany. With regard to operative measures, incisions, modes of drainage, sutures, etc., I can honestly say that most of those I use I have worked out for myself, but I must add (1) that many are the same, or nearly the same, as have been lately described by French, German, and American surgeons, and (2) that I did not divide the patella transversely until I had seen a case of Mr. Golding-Bird's. He, I believe, had been anticipated by Volkmann, who got the start of all of us English surgeons in these matters, and who is, moreover, a genius. To Mosetig-Moorhof, of Vienna, more than to any one else, we own the anti-tuberculous use of iodoform. I was using pure carbolic acid for the purpose when I heard of Mosetig-

orhof's observations, and I had good results with it; but doform has obvious and great advantages over a drug so ustic. I used to entirely cover the dressing with elastic ıdage before the turf-moss pads came over. While house-geon in Birmingham, I learnt from Gamgee the value of sure. Some British surgeons have also been working suc-ılly with erasion, especially Wright, of Manchester. If I d anything to confirm my faith in the methods I have enough could be found in a recent paper by Pro-ıer, of Lyons, the first authority in France on this d second to none in Europe. The procedures he nmends are very similar to those in use at the West lon.

men, is a brief ou line of what can be done, ı believe ought to be done, in cases of chronic knee-fitted for operative treatment. It is but an out-ın division of the subject would suffice for a complete ıt I think you would now be more wearied than you ıau my address been devoted wholly to some single ques-such as how to drain the knee after excision, or how to it after erasion. I would have liked to have described Annandale's operation for subluxation of the knee—which I have tried. It consists in suturing the too movable semilunar cartilage to the superjacent fascia lata and aponeurosis. Concerning simple drainage of the knee there is much to be said. Of suture of the fractured patella you must have heard and read *ad nauseam*. Amputation through the knee-joint is a subject of great interest, of which our fellow-member, Mr. Pick, has had exceptional experience. I will only say that I prefer Gritti's method to any other. Then there are many diseases commonly called of the knee, but really affecting neighboring structures—*e.g.*, genu valgum, genu varum, and also contractures and paralyses. And what a valuable addition to the surgeon's means is MacEwen's osteotomy for genu valgum!

But time, which can bring even tuberculous processes to an end, must stop even this long and, I fear, wearisome address. I would like, in concluding, to ask you not to imagine, because I have spoken almost entirely of operations, that I recognize no other surgery of the knee-joint. Sea-air, rest, plaster-of-Paris, and more than one variety of splint are inval-

uable means which no reasonable person should underrate. But to-night I thought I could interest you more by talking about other things; that is all. It would ill become me to sit down without referring to my predecessors in this chair—to those who, not less than your election, have made it an honor to preside here. We are a semi-suburban society—the most successful and important suburban scientific society in the world, I would venture to boast; and in what respect have we been more successful than in our past presidents? I have neither the learning nor classical culture of Dr. Vinen, nor the wide knowledge of Dr. Thudichum combined with originality. Nor can I claim the natural dignity and charm of manner of Mr. Hemming, or the perfect common sense and experience of Mr. Lawrence. But I hope and believe that I do share with Dr. Alderson in feeling a most intense desire for the success of this society, and appreciation of the honor you have done me. Such feelings have been the guiding-star of my immediate predecessor. They have shone out as plainly and brightly as any lighthouse-lamp or beacon-fire, visible not only to our late captain himself, but to every one of his crew. And now the helm is handed over to me, I have but to remember the past year in order to carry in mind a chart for the future.

CHAPTER II.

THE RESPONSIBILITY PLACED ON THE PHYSICIAN AND GENERAL PRACTITIONER BY THE MODERN PROGRESS OF SURGERY.[3]

GENTLEMEN:—The eloquent Cavendish Lecture recently delivered before our Society by Sir William Stokes, dealt with the altered relations of medicine and surgery to each other, and called attention more especially to the marvellous increase which has occurred in our times of the power of surgery to cure internal diseases and deeply-seated injuries.

I would like to recur to the same subject, only less broadly, confining these remarks to certain points. If the fullest and most successful use is to be made of the increased power of surgery, it is absolutely necessary that there shall be cultivated to the utmost the systematic co-operation of the physician with the surgeon. In the term "physician" is included the general practitioner, who cannot be more accurately described by any name than that of "family physician." A second necessity is that there should spread widely throughout the whole profession a good working knowledge of the earliest symptoms of such affections as intestinal obstruction, perforation of the appendix vermiformis, or of other parts of the digestive tract, rupture of the stomach, or of the bladder, or of the kidney, renal calculus, peritonitis, perityphlitis, the various affections of the female generative organs, amenable to surgical treatment, and, passing to another part of the person, intra-cranial abscess and hemorrhage and tumor. This anything but exhaustive list is given by way of example. Now, how many men are there in this room, how many are there in this city, how many in Great Britain, who have as good a practical knowledge of the diagnosis of, say, not only intra-cranial abscess, but even of renal calculus and acute intussusception as they have of typhoid fever and of pneumonia?

Let our own consciences reply. And yet these things, which are so obscure to many of us, are not so exceedingly rare; they are also terribly fatal, but wonderfully remediable by correct surgery promptly applied, while such diseases as pneumonia and typhoid often require no active treatment whatever. At all events, in dealing with the latter, a policy of waiting until the diagnosis is clear may do no harm.

But in the case of almost all the acute, and some of the subacute, internal diseases now brought into the province of surgery, to wait is to be lost. I would like to go into detail and tell of case after case in which the surgeon was appealed to by the practitioner, or even by the consulting physician, only when the shadow of approaching death had already crept over the patient. But as each case would be recognizable by those who had to do with it, there would be danger of appearing to reproach individuals, and to reproach at all is the last end I have in view. I know too well, and feel too strongly, how intensely difficult is the path we have to tread, how inaccessible the ideal goal at which we should aim. Nevertheless, let us set up this ideal, and with kindness and earnestness encourage each other to struggle onward toward it.

A first word of encouragement with regard to cases of intestinal obstruction is this: It is almost always, when once the abdominal cavity is opened, easy to speedily discover the exact nature, locality, and anatomical extent of the trouble. Such manœuvres as passing yards of small intestine, inch by inch, through the fingers are things to read about in books and avoid in practice. Often an intussusception can be felt at once; many have been discovered through the abdominal wall or per rectum before the operation. The first coil of intestine that appears in the wound, frequently, by its inflamed appearance, growing fainter in one direction, and more intense in another, guides straight to the constricting band or other source of mischief.

Secondly, the seat of disease or injury once found, it can usually be easily reached and dealt with in whatever part of the abdomen it may be. For instance, although the promontory of the sacrum and the right sacro-iliac synchondrosis cannot be dragged out of the abdominal incision, the latter can be pressed backward toward them. Let no one, therefore, be deterred from counselling operation for intestinal ob-

struction by the idea that the seat of disease will be either difficult to find or to get at.

Thirdly, an abdominal exploration, properly conducted, in a case not too far gone, can be made with almost absolutely no danger. Here is a typical example: Some years ago a man was admitted into W. L. H. ward of the West London Hospital with symptoms, recent and not severe, of strangulated or obstructed hernia. It was thought that the contents of the sac might be hooked back easily from within the abdomen. Two fingers were inserted through a small opening in the linea alba and the attempt made. As much force was used as was reasonable, but in vain. Then a regular ordinary herniotomy was done, and omentum found adherent to the fundus of the sac, which accounted for the irreducibility *à tergo*. The sac and omentum were excised. Recovery was as quick and uncomplicated as could be. The median abdominal incision produced no ill-effects whatever. Now let us suppose that the same man had had similar symptoms, but no hernia. He would have been a type of those cases in which there are suspicious but not conclusive signs of intestinal obstruction. Better that twenty such barren explorations should be made than that physician or surgeon should sit down and watch one genuine case of intestinal obstruction steadily and surely perish. But even in the practice of the most inveterate discoverer of mares' nests, no such proportion of barren explorations to successful operations would occur. There would more likely be twenty of the latter to one of the former. For, really, the serious cases are generally plain enough, even after a few hours. The acute pain, the gushing vomit, the collapse, the constipation which mark acute obstruction, do not form a collection of symptoms which are every day seen to clear themselves up. And there is usually a significant history to help to the diagnosis of a case of chronic obstruction.

With regard to acute obstruction, the case is well put by Mr. Greig-Smith in his most interesting and valuable work on abdominal surgery. "At once, or within a few hours, we ought to make a definite diagnosis. If we are convinced that it is acute obstruction, then operation should be performed at once; if we are convinced that it is not, another treatment equally definite ought to be pursued. From the beginning a

definite plan of treatment ought to be laid down, and this plan ought to be adhered to. Let it be either drugs or operation, and never that fatal compromise—operation when drugs fail."

In the surgery of the brain, to which Sir William Stokes particularly called our attention by his narration of his own instructive cases, quick diagnosis is not of so great importance as correctness, especially in the matter of localization. But it is possible to throw very valuable time away, and, especially in the treatment or neglect of surgical treatment of some of the ear diseases which lead to so large a proportion of the cerebral abscesses which occur. And correct localization is often greatly assisted by careful observations of where such symptoms as paralysis and spasms begin. The earliest of these symptoms are the most valuable. When the progress of the case has made paralysis more or less general then the symptoms no longer point to a particular centre. (A patient with suspected lesion of the brain or its membranes should be attentively and frequently watched, as the first symptoms of cerebral irritation, *e.g.*, convulsions, give the most valuable indication of the localization of the injury; also the temperature should be taken frequently, as an ominous rise may be sudden and rapid. Dr. Robertson of Glasgow thinks an intelligent observer should be in constant attendance on such cases.)

In general surgery it is equally important, if full advantage is to be taken of the improvements made by Lister and others, to act in time. Volkmann introduced the practice of classifying amputations, for statistical purposes, into "complicated" and "uncomplicated," the former being such as those in which pyæmia previously existed. In the class of cases termed "uncomplicated" the improvement in results which has followed the introduction of Listerism is well known to be wonderful. Not so with regard to "complicated" or pyæmic cases. These do very little better now than formerly. (For instance, Billroth's statistics show a gradual decline of the death-rate after major amputations in non-complicated cases from 35.1 per cent to 5.7 per cent; and of "complicated" cases he still lost 10 out of 17.) It is, even in 1888, still useless to lock the stable-door when the horse is stolen. In short, gentlemen, antiseptic surgery can do marvels, but not miracles. In order that it may do successfully its

mighty share in the salvation of human life, and the alleviation of human misery, it requires primarily and essentially an extensive and sound knowledge of symptoms and power of diagnosis on the part of the great body of the profession. This task of early diagnosis may be, in fact is, difficult, but it is honorable exactly in proportion to its difficulty. The acute, well-read, observant, and thoughtful man who diagnoses and localizes a cerebral abscess, whether he be consulting physician or country practitioner's apprentice, deserves more credit than the surgeon who, proceeding by rule of thumb, just as he would if carving a turkey, lets out the pus. The general standard of medical attainments is not now what it was, and the time is gone by when the highest ambition of practitioners was thought to be duly satisfied when, in the history of a case, they were merely named as having sent it to tne consultant.

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AIDS

TO

OPHTHALMIC MEDICINE

AND

SURGERY.

BY

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AIDS TO OPHTHALMIC MEDICINE AND SURGERY.

CHAPTER I.

DISEASES OF THE CORNEA.

A VERY large proportion of ophthalmic cases consist of ulceration of the cornea of one or other type, the following being the most common: 1. Phlyctenules, or phlyctenular ulcers; 2. Strumous, or asthenic ulcers; 3. Serpiginous ulcers; 4. Ulceration accompanying disease of the palpebral conjunctiva, such as purulent ophthalmia, or granular lids.

1. A *phlyctenule* consists of a small yellowish-white elevation on the surface of the cornea or the conjunctiva at or near the sclero-corneal margin. If on the cornea it tends to advance toward the centre, and a narrow leash of vessels runs to it from the margin. The phlyctenule consists at first of an accumulation of lymphoid cells immediately beneath the raised epithelium, and these may be absorbed without going on to ulceration, although very commonly the latter ensues. Ultimately a small nebula is left, and the little band of vessels ceases to be pervious, although its track may be recognized long afterward by means of direct examination with the ophthalmoscope.

Phlyctenular ulcers are usually accompanied by a fair amount of congestion of the eye; often cause considerable photophobia, and show a marked tendency to relapse. Those occurring around the corneal margin are the most difficult to cure; usually healing takes place under treatment in the course of one to three weeks. In some cases muco-purulent conjunctivitis supervenes on an attack of phlytenules, or *vice versâ*. Although occasionally seen in adults apparently of

perfect health, phlyctenular ulceration is met with generally in children, especially following measles, or some other eruptive disorder. Blepharitis, pustular eczema of the head and face, and enlarged cervical glands are common accompaniments.

Treatment.—Relieve photophobia by the use of a shade in front of both eyes; improve the general health by outdoor exercise; good plain food (especially plenty of milk in the case of young children); and give cod-liver oil, syrup of phosphate of iron, or some other tonic, if the patient is obviously out of

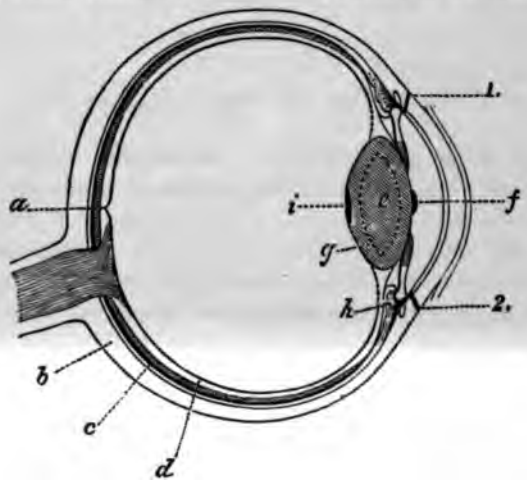

FIG. 1.—Diagrammatic section of the eye:—*a*, macula lutea, or yellow spot; *b*, sclerotic; *c*, choroid; *d*, inner layer of retina: *e*, lens; *f*, indicates the position of pyramidal or anterior polar cataract; *g*, dotted line in the position of lamellar cataract; *h*, ciliary body; *i*, position of posterior polar cataract. 1, section through sclero-corneal margin, as made in iridectomy for glaucoma; 2, section for extraction of cataract. Both these incisions are usually made at the upper border of the cornea, but for the sake of clearness are introduced at opposite sides in the diagram.

health. In nearly all cases the use of the yellow oxide and atropia ointment will be found to answer well. Formula:

Hydrargyri oxidi flavi, ...	gr. viij.
Atropiæ sulphatis, ...	gr. iv.
Vaselini, ...	ʒ i.

With a small brush a little of this ointment is inserted within the lids twice daily; in cases in which no photophobia exists the atropine may be dispensed with, and if the application cause much pain, etc., a weaker ointment should be used.

Should this treatment fail, a little calomel may be dusted into the eye once a day. Some authorities recommend the occasional application of nitrate of silver solution (ten or twenty grains to the ounce), but I have not seen any advantage follow from this painful method of treatment; others advise the use of eserine instead of the atropine. It is well to go on with the use of a weak yellow oxide ointment for some time after the inflammation has subsided.

2. *Strumous Ulcers of the Cornea.*—Much that has been said of phlyctenules applies to this form, although many cases of the latter present a greater extent of ulceration, and are more difficult to cure. A bad case of strumous ulcer may go on to perforation of the cornea, whilst a phlyctenule is always superficial. Strumous ulcers are commonly situated away from the corneal margin, phlyctenules at or near the latter. The opacity left by a healed strumous ulcer ("leucoma") is denser and more persistent than that resulting from a simple phlyctenule.

Symptoms.—Photophobia is nearly aways present in the early stages, and may be extreme, especially in young children with small central ulcers; the lids are then kept so tightly closed that it is very difficult to get a view of the ulcer. Pain, congestion, and lacrymation usually accompany the ulcer, and the irritation leads to the patient frequently rubbing the eye, and thereby aggravating the complaint.

Treatment.—In addition to the measures advised for cases of phlyctenular ulceration the following are useful: Boracic-acid lotion used as a fomentation, as warm as the patient can bear it; or the fomentum belladonnæ in cases in which the photophobia is marked. Setons applied at the temples have been almost superseded, but in very obstinate cases are, perhaps, worth trial; blisters are of but little use. Internally cod-liver oil and steel wine are valuable tonics; and, whenever possible, the child should be given the benefit of country air.

3. *Serpiginous ulcer* (synonym, Hypopyon or Infective Ulcer) occurs nearly always in elderly people, frequently following an injury, such as a scratch from a twig, etc., and tends steadily to progress, both in depth and extent. It has been shown to be due to the presence of septic micro-organisms, and the results of treatment have much improved since the introduction of antiseptics. The following features have

crossing the ulcer at its centre. Eserine is dropped in after the section has been made, and mild antiseptic lotions employed. It is remarkable what relief follows this operation in many cases, the ulcer healing in the course of a week or two; but should it not be successful, the wound may be opened daily for a few days with a fine probe, and atropine used instead of eserine. Even if the ulcer heals satisfactorily a considerable nebula will be left; and should this obstruct vision, a subsequent iridectomy for optical purposes may become necessary.

4. *Ulceration Secondary to Disease of the Conjunctiva.*—In the course of purulent ophthalmia the cornea is very liable to ulcerate or slough, partly owing to interference with the vascular supply, partly to the action of the pus and contained micrococci. This complication is to be feared if, on separating the lids, the cornea is seen to be hazy, and "like the eye of a dead fish" (Nettleship). No special treatment is indicated, but if the cornea be ulcerated in a case of ophthalmia neonatorum, great care should be employed in everting the lids, for fear of making the thinned part give way. It is remarkable how some cases in which the cornea appeared to be wholly opaque clear up, and the eye retains some degree of sight.

In cases of granular lids the cornea is often involved, either with superficial ulceration or with pannus (or both). Pannus consists in the presence of new vessels and cell-exudation on the surface of the cornea, and usually starts at the upper part, owing to the friction of the upper lid; indeed, the condition may be confined to the upper half of the cornea. It is very slow in progress, and when the granulations have become scar-tissue the cornea may remain for many years vascular on its surface, a condition kept up by entropion, and the consequent inversion of the lashes.

Ulcers of the cornea may also complicate chronic conjunctivitis not of the true granular type; and here mistakes in diagnosis are readily made; unless the lids are examined and their inflammation treated with astringents, it is practically useless to treat the corneal ulceration.

Treatment.—In every case in which vascularity or ulceration of the cornea is suspected to be secondary to granular conjunctivitis, etc., the lids should be everted, and if any active granulations are found they should be touched with blue-stone

or mitigated nitrate of silver stick every few days. It should always excite suspicion if the corneal lesions are confined to its upper half; for, though granular conjunctivitis nearly always affects both lids, the upper one is most severely involved, and has most influence in producing pannus or corneal ulcers. If the granulations have cicatrized, it is, of course, useless to continue with astringents, and care should be taken to ascertain that there are no ingrowing lashes which are irritating the cornea. If present, they should be either pulled out with epilation-forceps from time to time, or the hair-bulbs may be destroyed with electrolysis, or in bad cases a special operation is required (see Entropion). In electrolysis, the negative pole (a fine needle) is thrust into the situation of each hair-bulb, the lid being raised by a bone or ivory elevator; the positive pole is placed on the temple or forehead, and as the current passes minute bubbles will be seen to rise from the negative pole. If pannus persists after the condition of the lids which produced it has subsided, the operation of peritomy is sometimes useful. The patient is anæsthetized, a speculum introduced; an incision is made through the conjunctiva about $\frac{1}{4}''$ from the corneal margin all round, and the part within this removed with scissors and forceps going down to the sclerotic. The surface is left to granulate under boracic dressings, and the scar produced gradually leads to obliteration of the corneal vessels. The use of jequirity-seed infusions, or of inoculation with pus taken from a case of purulent ophthalmia of infants, has been tried in bad cases of pannus, and the latter has sometimes been very successful; but both measures are very uncertain in their results and are now rarely employed. With inoculation there is a risk of causing sloughing of the cornea, or panophthalmitis, a danger from which peritomy is free.

Herpes of the Cornea.—Sometimes small vesicles are met with in the course of herpes frontalis or nasalis, with or without iritis. In old glaucomatous cases, or in eyes lost from some other cause, small bullæ may form on the cornea, and occasionally herpetic vesicles develop in connection with a febrile attack (as in herpes of the lips). Finally, herpes of the cornea appears to occur very rarely as an independent affection, the cause of which is perfectly obscure. There is then much pain, photophobia, etc., and the treatment advised is the use of calomel powder or destroying the vesicle walls.

It may be noted that impaired nerve supply to the cornea is one cause of ulceration of its surface, as in paralysis of the fifth nerve. If the lids cannot cover the eye, as in facial paralysis, or severe exophthalmic goitre, ulcers may form on the cornea.

Interstitial Keratitis.

This peculiar form of corneal disease generally affects both eyes, though not always at the same time, and is most common between the ages of six and sixteen, though sometimes it develops as late as thirty or thirty-five. Relapses, though infrequent, are not unknown, sometimes occurring after an interval of many years. Two chief types are met with: 1. A ground-glass opacity of the whole cornea. 2. Vascularity of the substance, a great number of the vessels giving a red or pink color. These two conditions are, however, frequently seen together. Typical interstitial keratitis may be considered to be always due to inherited syphilis, which reveals itself by one or other of the following signs. The most important, perhaps, is the malformation of the permanent teeth, especially the upper central incisors. These are narrower at their cutting edge than at the base, and present a notch in the centre of the former. This narrowing is sometimes described as the screw-driver deformity, and may be present also in the lateral incisors or the canines of either jaw, but (as Mr. Hutchinson insists) the upper central incisors are the test teeth of inherited syphilis. The palate is generally high and narrow (though this malformation is not peculiar to inherited syphilis), the forehead grooved horizontally just above the eyebrows with a transverse projection above this. About the time the eyes become inflamed, a peculiar and inveterate form of deafness frequently comes on, and occasionally periosteal nodes are met with on the tibia or other bones. In a small proportion of cases both knees become affected with chronic synovitis, comparatively painless, and entirely clearing off after a few weeks or months. The bridge of the nose is often sunk, and radiating scars around the mouth are not uncommon.

Fig. 8.— Teeth typical of Inherited Syphilis (permanent set, upper row). Central incisors notched and narrowed at their cutting edge.

There is generally a history of syphilitic symptoms in infancy (snuffles, rash, condylomata ani, etc.), and the mother has very likely had repeated miscarriages or still-births, and if there are older children living than the patient in the family, they may also have suffered from interstitial keratitis or other suspicious symptoms.

Sometimes, however, interstitial keratitis is the only symptom of the diathesis.

Its course is always slow, from three to twelve months (often longer) elapsing before the cornea clears, and not only are nebulæ frequently left, but myopia is a not uncommon sequel. Years afterward the keratitis may be recognized, although the cornea has apparently cleared, by the presence of numerous fine lines in the cornea, detected by magnifying ophthalmoscopic examination.

In a few cases the cornea remains permanently opaque, but generally a very fair amount of vision is regained, and frequently no trace remains but the fine lines mentioned, which do not materially interfere with vision.

The chief complications are the following: 1. Iritis frequently present, and, since it may be masked by the corneal opacity, atropine is nearly always advisable during the active progress of the disease. 2. Choroiditis — generally of the patchy or disseminated form, but sometimes simulating retinitis pigmentosa. 3. Inflammation of the ciliary region—leading to secondary glaucoma in some cases, and always gravely affecting the prognosis.

Ulceration of the cornea is very rarely met with, but does occur in a few cases.

Myopia, as a not infrequent result of interstitial keratitis, has already been mentioned, depending on slight bulging of the weakened cornea. If the disease is very severe, a more marked yielding may ensue, producing anterior staphyloma. In some cases a glaucomatous condition may arise, the anterior chamber remaining very deep, and the cornea sometimes becomes oval instead of round. In fact, a condition allied to buphthalmos (see Appendix) may be set up.

Treatment.—A prolonged course of mercury given in small doses is certainly of value, and many surgeons combine iodide of potassium with it. Thus:

Liq. hydrargyri bichlor., . . . ℥ i.
Pot. iodidi, ... gr. iij.
Aquæ destill., ... ℥ i.
T. d. s. p. c.

If the patient is anæmic, syrup of the iodide of iron should be given instead of the potassium salt. Atropine should be used so long as the inflammation is in the active stage, and a convenient form is the ung. hyd. ox. flav. cum atropiâ. In a few cases, however, permanent dilatation of the pupil has followed the prolonged use of atropine in interstitial keratitis, and it is therefore best to leave off its use as soon as possible. The corneal opacity clears very slowly, and sometimes iridectomy is performed, but it rarely does much good. The increase of tension sometimes present does not indicate it unless very pronounced.

Other Diseases of the Cornea.

Arcus Senilis.—Just within the corneal margin two lines of white opacity are formed, one in the upper part of the cornea, the other in the lower (the former being often the most marked). These lines ultimately meet to form a ring, which may gradually increase in width so as even to interfere with vision in a few cases. The pathology consists in a deposit of fat in the corneal cells, and the patients are usually over fifty years of age. Arcus senilis, however, is by no means always present in very old subjects; there seems to be a family predisposition to its early development. Frequently it is met with in patients with atheromatous vessels; still its presence does not materially alter the prognosis of an operation on the cornea, *e.g.*, cataract extraction.

Conical Cornea.—The centre of the cornea becomes thinned and pushed forward while retaining its transparency, and in severe cases the conicity may be easily recognized by looking at the eye from the side. Long before this can be effected, however, conical cornea may be detected by keratoscopy (Keratoscopy, see Refraction, p. 422), the pupil having been dilated. Instead of the usual shadow moving from side to side a circular or crescentic shadow is obtained. It is most important to recognize the early stages of conical cornea, since it gives rise to irregular astigmatism and considerable defect

of vision, which cannot be benefited as a rule by glasses. Generally both eyes are affected, and the patients are most commonly young women; the pathology is quite obscure. No treatment is of much avail unless the disease is so advanced that vision is greatly impaired; an operation is then justifiable. The summit of the cone may be excised with a Graefe's knife, or cauterized, or trephined with a very small special trephine. In all these operations the anterior chamber is penetrated, and there is risk of an anterior synechia forming; the pupil should hence be well dilated with atropine before the operation.

Lead Deposits on the Cornea.—If a case of corneal ulcer or abrasion is ignorantly treated with lead lotion a white deposit of a salt of the metal is formed, which persists as a characteristic opacity; it can be scraped off with some difficulty. Hence the rule never to use lead lotion in any case where the suspicion exists of loss of corneal surface. Nitrate of silver, if used for long in ophthalmic cases, may produce a brown stain of the conjunctiva, and, to a less extent, of the cornea.

CHAPTER II.

DISEASES OF THE CONJUNCTIVA.

1. *Muco-purulent Ophthalmia* (syn., Catarrhal Ophthalmia).—A contagious form of conjunctivitis, characterized by slight muco-purulent discharge, pain and irritability (a "feeling of grit in the eye" is a common complaint of the patient) and tending to spontaneous recovery after a week or two's duration (sometimes less, sometimes more). Generally both eyes are affected; the lids are stuck together in the morning; and even if photophobia be not marked, any attempt at work is almost unbearable during the first few days. It is most prevalent in the spring and autumn, attacks persons of all ages, and often is seen to affect all the members of a household in greater or less degree. It is quite distinct from true purulent ophthalmia, but is often accompanied by the formation of little pustules or phlyctenules around the corneal margin, or by ulcers on the cornea. Severe nasal catarrh, or blepharitis, is also not very infrequent.

Treatment.—Lotio zinci sulphatis (two grains to the ounce), lotio acidi boracici cum zinco (one grain of sulphate of zinc, boracic acid ten grains to the ounce, with perhaps a little glycerin), or lotio argenti nitratis (one to two grains to the ounce), may be used three times daily; some simple ointment, such as the unguentum cetacei, being applied along the lids in the evening. An ointment containing four grains of yellow oxide of mercury to the ounce of vaseline is useful if the case is obstinate and phlyctenules are present.

2. *Purulent Ophthalmia.*—A severe and dangerous form of conjunctivitis, due in nearly all cases to contagion from gonorrhœal or vaginal discharge. The most common examples are in infants infected at the time of delivery (ophthalmia neonatorum). The discharge is noticed about the third day after birth; the lids become swollen, and their edges stuck

together; on opening them yellowish pus and lymph exude, and on everting the lids the conjunctiva is seen to be extremely congested and granular. There is great risk to the cornea from ulceration or sloughing if the case is neglected, and many cases of incurable blindness are due to this cause.

In gonorrhœal conjunctivitis of adults the contagion is generally conveyed by the finger, etc., from the urethra; the symptoms are similar, but there is perhaps even more liability to chemosis, and even greater risk to the cornea. One or both eyes may be affected; if only one, the other should be protected by the use of a Buller's shield (a watch-glass secured thoroughly in front of the eye by perforated strapping, or covered up by an antiseptic dressing.)

FIG. 4.—Purulent Ophthalmia—swelling and excoriation of lids, discharge of pus.

Treatment.—The lids should be separated and the discharge thoroughly washed away by very frequent use of an antiseptic and astringent lotion (carbolic acid 1 in 150, or the boracic and zinc lotion, or sulpho-carbolate of zinc four grains to the ounce, or nitrate of silver one to three grains to the ounce). Carbolic acid is well tolerated by the cornea even as strong as 1 in 40 solution, and the constant use of compresses soaked in iced carbolic solution is perhaps the best continuous treatment for gonorrhœal ophthalmia in adults. The lids should be prevented from adhering by the use of vaseline or ung. cetacei, so as to give a free vent to discharge, and once a day the surgeon should carefully evert them, and having washed or irrigated all lymph and pus away, examine the state of the cornea and apply a solution of nitrate of silver to the whole conjunctival surface with a brush. Twenty grains to the ounce may be used, and a rather weaker solution as the case improves (ten to fifteen grains). Sometimes nitrate of silver seems to lose its effect, and then a change should be made to chloride of zinc (five grains to the ounce); but on the whole, nitrate of silver is by far the most effective. If the swelling of the lids and spasm of the orbicularis are very

great, and prevent the proper examination of the conjunctiva, cutting through the outer canthus (the outer union between the lids) with scissors is recommended, but it is very seldom necessary.

Thorough cleansing and frequent application of weak antiseptics, and the daily use of a strong solution of nitrate of silver constitute the treatment, which rarely fails. In midwifery practice among the poor, attention should be paid to the infant's eyes within the first few days, and it would seem that applying a weak solution of nitrate of silver to the conjunctiva at birth may prevent the onset of ophthalmia.

Results.—Although the cornea may clear entirely, the subjects of purulent ophthalmia in infancy sometimes reveal in adult life its occurrence by the presence of a small pyramidal cataract, or by nystagmus.

A number of the cases recover very good vision, although there has been ulceration of the cornea with adhesion of the iris; it is, indeed, wonderful how far recovery can take place after the cornea looks to be lost. A deep diffused haze, or a number of separate ulcers, or a single circular one round the corneal margin, however, are dangerous signs, and may forerun complete sloughing or formation of an anterior staphyloma, etc. If a large perforating ulcer have formed, the lens may escape and the eye shrink.

3. *Granular Ophthalmia* (syn., Trachoma).—This is often spoken of as "granular lids," since the inflammation involves chiefly the palpebral conjunctiva. It is a contagious, very chronic form of conjunctivitis, seen almost entirely among the poorer classes, and characterized by the formation of little nodules (composed of lymphoid cells) in and just below the conjunctival surface. The term "sago-grain granulation" is often used; it must be remembered that the little nodules, which are best seen toward the back part of the lids on everting them, are sometimes gray and semi-transparent, but of a reddish color as a rule. It is apparently due to a micro-organism, and it occurs in epidemics among ill-fed children (as in the Irish famines, among the poorer class of Egyptians, or in pauper-schools in England). The contagion may be conveyed by means of washing-towels, etc., and probably in hot countries by the action of flies. The inflammation, whether treated or not, as a rule drags on its course for

many months or even years, and from time to time its subjects are liable to purulent or muco-purulent attacks, which may endanger the cornea. The chief complications are: 1. Pannus (see Diseases of the Cornea, p. 347), which begins and is sometimes limited to the upper half of the cornea. 2. Scarring of the lids, which, if deep, produces entropion and in-growing eye-lashes. 3. Nebulæ, or ulcers of the cornea.

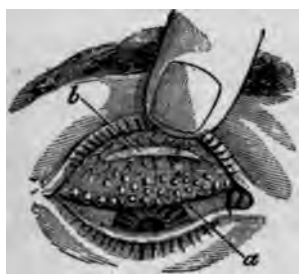

Fig. 5.—Granular upper lid everted:—*a*, granulations; *b*, scar-tissue.

During the progress of granular ophthalmia, the patient complains of more or less photophobia and discharge from the eyes, with some lacrymation; the edges of the lids look congested and thickened, and any use of the eyes is hardly possible in severe cases. When in a very chronic condition, however, there may be merely irritability, with congestion on attempting to do much reading, etc., or on exposure to the wind. An eye that has gone through granular ophthalmia is left weak and irritable for long.

Treatment.—No treatment is known which will produce a rapid cure, and attempts to effect this by too vigorous cauterization, or scraping away the granulations, usually lead to excessive scarring and entropion. On the other hand, much good may be done by improving the patient's general health, and methodically using astringents to the everted lids for a period of many months. The application should be made twice or thrice weekly in severe cases; less often in milder ones and those which are recovering. Cocaine applied a few minutes before somewhat eases the pain, as does freely bathing the eyes with cold water subsequently. The astringent should be applied to all the granulations, and especially to what is known as the retrotarsal fold. The best forms are the following: 1. Lapis divinus—Sulphate of copper, nitrate of potash, and alum, equal parts fused together, with a little camphor added. 2. Mitigated nitrate of silver—One part of the salt with two parts of nitrate of potash. 3. Pure carbolic acid, applied with a little curette or spoon. 4. Solutions of nitrate of silver (ten or twenty grains to the ounce). 5. Crystallized sulphate of copper.

The patient may be ordered astringent drops or lotion of nitrate of silver (one to three grains to the ounce), of sulphate of copper (one to two grains), or the boracic and zinc sulphate lotion. But it need hardly be said that to apply astringents properly to the diseased surface requires eversion of the lids by the surgeon.

For the special treatment of pannus see p. 348.

Sometimes very small "granulations" are seen in association with chronic conjunctivitis and irritability of the eyes in cases which can hardly be regarded as true granular ophthalmia, but which require a somewhat similar treatment.

4. *Chronic Conjunctivitis.*—Persistent slight congestion and lacrymation with irritability of the eyes is met with under a variety of conditions; sometimes associated with lacrymal obstruction (which see, p. 363), sometimes with uncorrected errors of refraction; or it may be set up by prolonged work in ill-ventilated rooms, or from exposure to great heat or glare of the sun. In senile patients this form of conjunctivitis is often seen with a relaxed condition of the conjunctiva or slight ectropion. Removal of the cause, if any can be found, the use of mild astringent lotions, protective tinted or smoked glasses, and improvement of the patient's health, are the chief measures of treatment.

The term diphtheritic conjunctivitis is sometimes applied to cases in which a tough pellicle of lymph is formed on the conjunctiva, which bleeds on its removal, but its relation to true diphtheria is in most cases doubtful. The disease is very rare in England. Astringents should not be used in its treatment, but warm antiseptic lotions are advisable. Quinine lotion (four grains to the ounce) continuously applied is recommended by Professor Tweedy.

Diseases of the Eyelids.

Of these, by far the most common is blepharitis (syn., Tinea or Sycosis Tarsi: Tinea is a bad term, since the disease is not due to a cryptogamic cause). It is generally met with in strumous children or otherwise unhealthy subjects, and varies greatly in severity, showing little or no tendency to spontaneous cure. An attack of measles or scarlet fever is often the predisposing cause. Sometimes the disease is part of an ecze-

matous eruption on the face; at others, the hair-bulbs and adjoining glands are the chief seat of the inflammation. Slight gummy discharge, minute ulcers, deposit of crust along the edges of the lids, and dropping out of the hairs are the chief symptoms. In inveterate cases the hair-bulbs are destroyed, and a condition known as lippitudo produced; there may then be epiphora, due to eversion of the lids. The longer the disease has existed the more difficult is it to cure. Ulcers of the cornea and phlyctenular conjunctivitis are not infrequent complications.

Treatment.—Order the patient to remove all the scab by bathing with warm alkaline lotion (five grains of carbonate of soda to the ounce) two or three times a day, and afterward to apply a dilute mercurial ointment (the unguentum hydrargyri nitratis dil., or one containing four to eight grains of the yellow oxide to the ounce of vaseline or lard). Borax or a solution of tar (liq. carbonis detergens, five drops to the ounce) may be added to the lotion. Painting the edges of the lids with a twenty-grain solution of nitrate of silver often does good, and in cases where the hair-bulbs are obviously inflamed epilation may be required at intervals. Attend to the patient's general health, and if marked hypermetropia or other error of refraction be found on testing, order the appropriate glasses.

Dermoid Cysts.—The favorite position for congenital cysts about the orbit is over the external angular process of the frontal bone, to the periosteum of which they are nearly always attached, and often they somewhat indent the bone. As they lie under the frontalis muscle the skin over them is movable; their fibrous wall is very variable in thickness, and their contents consist of cholesterin, sebaceous matter, abortive hairs, and more or less fluid. They often reach the size of a hazelnut in the first year, and show little tendency to increase subsequently.

Treatment.—Remove the whole cyst through an incision parallel with the eyebrow; avoid opening the cyst during the operation if possible, and if it is opened be careful to remove the last remnants. Sew up the wound with fine sutures, and dress with iodoform, spirit lotion, or some other antiseptic.

Syphilitic Ulcers.—Both primary chancres and tertiary syphilitic sores are occasionally met with. Chancres are

always accompanied by characteristic gland enlargement in the pre-auricular or sub-maxillary region. Tertiary ulcers are difficult to cure and tend to relapse; the patients are most often women who have had syphilis severely. Iodoform, iodide of potassium internally, with tonics, constitute the chief methods of treatment.

Chalazion (syn., Meibomian Tumor or Cyst).—A small rounded tumor in the substance of the eyelid, which commences in the Meibomian gland layer, formerly wrongly supposed to be glandular cysts due to duct-obstruction. They are really made up of a gelatinous mass of small cells, which tends to inflame and suppurate. Occur most often in young adults, and are noticed as firm rounded lumps under the skin of the eyelid. Some patients show a marked tendency to their repeated development.

Treatment.—Evert the eyelid (generally the upper one), make a crucial incision with a Beer's knife into the tumor from

FIG. 6.—Beer's knife.

the conjunctival aspect, introduce a small sharp scoop, and by means of this and of pressure on the eyelid remove the granulation mass. Pass the finger over the eyelid to ascertain that the tumor is completely removed. It is very rarely necessary to make the incision through the skin instead of the conjunctiva.

A *Stye* is a pustule or small abscess at the margin of the lid, probably around one of the sebaceous or other glands at this part. It has nothing to do with the Meibomian glands.

Treatment.—Touch the inflamed point with nitrate of silver stick if the case is seen early; otherwise apply warm boracic fomentations, and incise when there is a definite abscess. Attend to the patient's general health, as styes tend to recur.

Molluscum Contagiosum.—Occurs in young children, and is characterized by little round or oval projections, which generally show a dark spot at their summit. They occur in crops on the face (the eyelids being a favorite site) or other parts of the body, become pedunculated as a rule, and may then inflame and drop off. They are certainly contagious in a mild

degree; for example, they are sometimes seen on an infant's face and on its mother's breast or hands, and can be inoculated with difficulty. Microscopically they consist of lobulated masses of peculiar cells, resembling sebaceous matter, but they do not seem always to originate in sebaceous glands.

Treatment.—If pedunculated, snip off with scissors; if not, cut into the little tumors and squeeze out their contents.

The small ulcer with inflamed base left after a molluscum contagiosum has dropped off has been mistaken for a chancre.

Rodent Ulcer.—Is a peculiar form of epithelioma characterized by the following features: 1. Very slow growth; but in some cases, if left alone, it tends to eat steadily into the tissues below, destroying the globe and lids, and even invading the bones. 2. The ulcer has a raised, sinuous, "rolled" edge. 3. The lymphatic glands are not involved, however long the disease has lasted. 4. Microscopically there are down-growths of epithelium derived from the rete mucosum, or deeper layer, and not containing cell-nests like ordinary epithelioma. The cells in the down-growing bands are smaller and less defined than those of epithelioma.

Although it may start at any part of the eyelids or adjoining skin, the commonest place is the lower lid toward the inner canthus.

Treatment.—If possible excise the whole ulcer; scraping or cauterization is less likely to prove effectual.

Horns.—Grow generally from the middle of one or other eyelid, usually the lower, and in adult life or old age, and seem always to commence in connection with a sebaceous gland. Hence though toward the apex they may be very hard, at their base they are comparatively soft.

Treatment.—Excise with scissors or knife, taking care to remove the base of the horn to prevent recurrence.

Xanthelasma Palpebrarum.—Depend upon the presence in the true skin of the eyelid of cells containing a peculiar yellow fat, in and just beneath the rete mucosum. The favorite site is the inner part of the upper eyelid, and the affection is generally roughly symmetrical. A yellowish patch (not unlike wash-leather in appearance) is seen, slightly raised, and not at all indurated. Develops usually after middle life, especially in those who are prone to deep pigmentation of the lids (pa-

tients who suffer from frequent bilious headaches, etc.). No treatment is required.

Lupus is occasionally met with on the conjunctival surface of the lids, nearly always in association with other patches on the face. Its chief peculiarity is the formation of large soft granulations. Its treatment consists in scraping and cauterization.

Entropion.—Consists of inversion of one or both lids, and is nearly always due to scarring of the conjunctiva and subjacent tissues. Its most frequent cause is granular ophthalmia, and hence it is especially met with in the upper lid. The eyelashes become turned inward toward the globe, so as to keep

Fig. 7.—Entropion of both lids.

Fig. 8.—Operation for Entropion—grooving the lid.

up constant irritation of the cornea, and this often leads to or is associated with pannus. Spasmodic entropion is sometimes met with after operations on the eye (*e.g.*, cataract extraction), and it is also occasionally seen in very old people without obvious cause. Both these are much milder forms of entropion than the persisting one resulting from granular lids, in which the tarsal "cartilage" may be much curved and deformed. In such cases relief can be given by operation, there being a great number of methods of performing this. One of the best is the following: The patient is anæsthetized, and a broad lid-elevator inserted and held by the assistant. With a Beer's or other kind of knife, the surgeon cuts a groove along the whole border of the lid, one or two millimetres inside the row of eyelashes, avoiding the punctum lacrymale. The incision must go down into the edge of the tarsal cartilage. He then excises a semilunar strip of skin

from the lid, the lower border of the incision being about two millimetres outside the ciliary border. The amount of skin removed should depend on the degree of entropion. Sutures and simple dressing are applied, the wound in the conjunctiva being, of course, left open, and allowing the edge of the lid to be drawn outward.

Another operation (Burow's) consists in simply making a deep groove parallel with and three millimetres inside the ciliary border along its whole length, by means of scalpel and scissors. The incision should go down through the tarsal cartilage, but not the orbicularis muscle.

A third operation, suitable for mild cases (*e.g.*, senile entropion), consists in excising a strip of skin from the lid, in the same manner as just described.

Ectropion.—Persistent eversion of the lid, nearly always the lower one, which usually produces displacement of the lacrymal punctum, and more or less epiphora. Mild degrees are seen in old people with chronic conjunctivitis; more severe forms are due to scarring from various causes—burns, strumous periostitis of the upper jaw, wounds with loss of substance, operations for removal of rodent ulcer, etc. The first class may be treated by excising a strip of conjunctiva or by the V Y operation. In this two incisions are made which meet below, and detach a flap of skin, with its base toward the edge of the lower lid. The apex of the flap is then displaced upward, and by sutures the V-shaped wound is converted into a Y. If there is a scar fixing the lower lid to the upper jaw it should be freely divided subcutaneously. When there has been much loss of substance of the lid, nothing short of transplantation of skin will be of any service. The flap taken should be decidedly larger than would appear at first sight necessary, since it always shrinks, and should include the whole thickness of the true skin.

Fig. 9.—Ectropion of both lids, with conjunctivitis.

The results of these operations for ectropion are often not very good, and very severe cases, such as result from burns of the cheek or lupus, are practically incurable.

CHAPTER III.

LACRYMAL OBSTRUCTION, ETC.

IT will be remembered that the tears, after leaving the ducts of the lacrymal gland beneath the outer end of the upper lid, are swept across the eye by the action of the orbicularis palpebrarum, which has its chief fixed point at the inner canthus. At the same time, partly by the action of the tensor tarsi, the two puncta at the inner border of each lid are opened and directed to receive them. They then pass along each

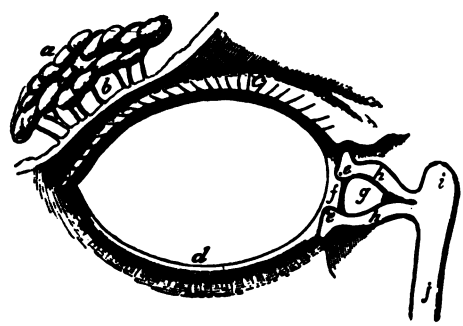

FIG. 10.—Lacrymal apparatus. *a*, Lacrymal gland; *b*, ducts; *c*, *d*, margins of lids; *e*, *e*, puncta lacrymalia; *g*, caruncle; *h*, *h*, canaliculi; *i*, lacrymal sac; *j*, nasal duct.

canaliculus into the lachrymal sac, and down the nasal duct to the inferior meatus of the nose. Any interference with the muscular mechanism, with the position of the puncta, or any obstruction in the drainage-apparatus, will cause the tears to flow over the cheek, a condition known as epiphora. Hence epiphora is met with from a variety of causes, facial paralysis (involving the orbicularis and tensor tarsi), chronic blepharitis or ectropion (displacing or obstructing the puncta); perhaps the most common cause is chronic inflammation of the nasal duct leading to stricture. The latter is occasionally due to

disease of the bones forming the nostril (as in inherited syphilis), but generally no obvious cause can be found. It may develop at any age, and is most common among females (80 per cent—Nettleship). The tears collect in and distend the lachrymal sac (forming mucocele), and this can be recognized by pressure at the inner canthus emptying the sac backward through the canaliculi. Inflammation in and around the sac may readily occur, and thus a lacrymal abscess form, which points below the tendo oculi, and which is usually very painful and accompanied by much surrounding inflammation. In cases of lacrymal obstruction without abscess, epiphora is the chief complaint, slight conjunctivitis being often set up.

FIG. 11.—Lacrymal Abscess, which has burst below the tendo oculi.

Treatment.—Where the disease is due to blepharitis, etc., or where there is no mucocele, and hence probably no obstruction to the escape of tears, astringent lotion or drops should be tried. Sulphate of zinc, two to five grains to the ounce; chloride of zinc, one to two grains, or weak nitrate of silver lotion (in cases of blepharitis only), may be ordered to be used two or three times a day. In cases due to displacement of the puncta the treatment should be directed to the cause; but sometimes relief is obtained by slitting up the lower canaliculus with a Weber's probe-pointed knife. In this operation the surgeon stands behind the patient, insinuates the probe-point within the punctum, makes the lower lid tense, and straightens the canaliculus by drawing the lid outward with one index-finger, while he pushes on the blade of the knife, at the same time

FIG. 12.—Weber's canaliculus-knife.

raising its handle, so as to cut through the whole length of the upper wall of the canaliculus.

If a mucocele or threatening lacrymal abscess be present this operation should be performed, and as soon as the inflammation has subsided under the use of mild astringent or seda-

tive lotions (lotio plumbi, or lotio acidi boracici) the nasal duct should be probed.

The treatment of stricture of the duct by means of dilatation with probes is similar to, but more unsatisfactory than, the treatment of urethral stricture by dilatation. It is very painful, the obstruction is very liable to relapse, and much care is required in passing the probes to avoid injuring the walls of the duct. A more satisfactory method than the occasional passage of probes is to introduce a leaden style, the upper end of which is hooked down and rounded off, so as to prevent it slipping in. The style can, of course, only be introduced after a moderate-sized probe has been got through, but it can be worn for months at a time without causing much discomfort. An antiseptic lotion should be used while the style is kept in, and it may also be of advantage in some cases of dacryocystitis (inflammation of the lacrymal sac) to frequently wash out the sac with a syringe, the point of which is introduced along the previously slit-up canaliculus.

If a lacrymal abscess be on the point of bursting it may be opened by a puncture just below the tendo oculi; but as soon as practicable the canaliculus should be laid open and the cause treated.

Cases of obstruction from necrosis of bone are, as a rule, unsuited for operation.

CHAPTER IV.

DISEASES OF THE IRIS.

Iritis.—**It will be remembered that the iris lies immediately in front of the lens capsule, its pigmented or uveal surface resting against the latter (see Fig. 1). In all forms of inflammation of the iris the tendency is to contract adhesions with the lens ("posterior synechiæ"), and often to leave deposits of the uveal pigment upon its surface. The pupillary margin is the part of the iris in which its capillaries are most plentiful, and hence the inflammatory process is generally most marked at this part. By the use of mydriatics (of which atropine is the strongest) it is possible to draw away the inflamed iris, and so prevent adhesions being formed, or sometimes** even to rupture them; but the treatment, to be effective, must be commenced early in the case. Hence the great importance of recognizing the onset of iritis, of which the chief symptoms are the following:

1. The pupil is altered in shape; it may be a little smaller than that of the other eye, and does not dilate so well when the eye is shaded; it is either sluggish or immobile. If homatropine be applied, and the eye examined twenty minutes later, the difference in shape becomes marked, the pupil being oval, or quite irregular, owing to adhesions. If a circular adhesion exist all round the pupillary border, of course no dilatation takes place, unless the adhesion be of very recent date.

2. The color of the iris is altered, a greenish tint being the most usual; but an originally brown iris does not change much. In some cases little nodules of lymph are seen, and sometimes minute red streaks (vessels) running toward the pupil. At the border of the latter, by careful focal illumination, one or more little projections can be often observed, generally of a white or brown color. The reticulated surface of the iris is blurred, owing partly to turbidity of the aqueous

and cornea, partly to congestion and effusion of lymph into its substance.

3. There is generally marked congestion of the eye, especially immediately around the corneal margin, and the deeper vessels are evidently involved in this congestion. But frequently the whole conjunctiva is red, and the character of the congestion is by no means a safe guide as to the presence of iritis. The mistake is often made of supposing a case of iritis at first to be simple catarrhal ophthalmia, a mistake which would nearly always be avoided by using homatropine and examining for the first-mentioned symptom.

4. Besides pain in the eye and more or less photophobia, there is generally pain referred to the forehead or nose. This referred pain is due to the fact that the iris is supplied by the nasal branch of the ophthalmic nerve (long ciliary twigs), and, as a rule, the pain in acute irititis is most intense in the distribution of the supra-orbital division.

These are the cardinal symptoms of iritis which are present in acute cases. In mild cases, however, one or more of them may be very little marked, and in such the action of the pupil to light, and still more to homatropine, is the only conclusive test. The tension of the globe in iritis is not infrequently somewhat raised, and the question of glaucoma may be suggested. It is, of course, the worst possible treatment to use atropine in a case of glaucoma, but occasionally it is necessary to employ it in iritis, although the tension may be increased. We now have to consider the causes of iritis. Of these by far the most important are secondary syphilis and rheumatism.

1. *Syphilitic Iritis.*—Occurs usually from three to six months after the chancre (in congenital syphilis at the same date from birth); rarely affects both eyes simultaneously, but very often the two in succession. The second eye may become affected although the patient is under full mercurial treatment for iritis in the other eye. It very rarely relapses, and is rapidly improved by thorough mercurial treatment. It is in this form that the so-called gummata of the iris are met with: little pinkish-white nodules, on which new vessels can be made out. Sometimes single, they are generally multiple, and tend to form large posterior synechiæ. Lymph in the anterior chamber may accompany them.

Secondary syphilis probably accounts for about fifty per

cent of the total number of cases of iritis. Syphilitic iritis in infants is decidedly rare; as already mentioned, it occurs within six months of birth (probably in a few cases it comes on in utero) and is much more common in female children than males (consult Hutchinson on Syphilis). The same tendency to free effusion of lymph is seen here as in adults, and the pupil may become occluded from it. Besides these infantile cases, we have to remember that iritis may come on at or after puberty, as a complication of interstitial keratitis.

2. ***Rheumatic Iritis.***—Is met with in adults; generally affects only one eye at a time; tends to form firm adhesions, but not to develop nodules of lymph, and very frequently relapses. Its subjects are generally those with a history of rheumatic or "gouty" symptoms (in which lumbago may be included), and the iritis is often brought on by exposure to wet or cold. The congestion, photophobia, and pain are all more severe than in syphilitic iritis; but the tendency to relapse is perhaps the best-marked feature. In some cases the diagnosis is difficult between the two forms, and it must be based on the consideration both of the symptoms and the previous history of the patient. To recapitulate the chief points in the differential diagnosis·

SYPHILITIC IRITIS.	RHEUMATIC IRITIS.
1. Frequently small nodules of lymph present.	1. Tends to produce tough adhesions without nodules of lymph.
2. History of secondaries within about six months of the attack, or presence of syphilitic symptoms.	2. History, perhaps, of previous attacks, or of rheumatic symptoms.
3. Does not tend to relapse.	3. Pain, congestion, etc., very severe. 4. Frequently relapses.

3. *Serous Iritis.*—Occurs, as a rule, in women; is extremely slow in progress, and is characterized by the deposit on the back of the cornea of a number of little whitish dots of lymph, which form a triangle, with the base downward, and the apex toward the centre of the cornea. The disease is regarded as a lymphangitis of the eye (De Wecker), and frequently its

subjects are anæmic, or run-down in health (sometimes with glandular enlargements in the neck, or giving the history of other scrofulous symptoms).

One or both eyes may be affected; as a rule, it is symmetrical.

Serous iritis is sometimes accompanied with patches of disease in the periphery of the choroid, or with vitreous opacities. Compared with syphilitic or rheumatic cases it is a more chronic form of iritis, and, as already noticed, the lymph deposit generally persists for many months, or may never wholly disappear.

It occurs as a symptom of sympathetic ophthalmia (which see), or occasionally in rheumatic subjects.

4. *Iritis from Inherited Gout.*—This, though a rare disease, deserves notice from its peculiar features. It is very insidious (*i.e.*, pain and congestion may be but little marked), and the ciliary body is inflamed at the same time, so that the eye is often very seriously impaired, apart from the formation of iritic adhesions. It may come on quite early in life, and though the patient may never have had any other gouty symptom, there is a history of gout in the parents.

In 5, *Gonorrhœal Iritis*, there is the same tendency of the ciliary region to be involved, so that dusky patches of congestion and exudation are seen in this part (cyclitis, or sclerotitis). In other respects it is closely allied to rheumatic iritis, and its subjects are nearly always those with gouty or rheumatic tendencies. In such a patient every attack of gonorrhœa may be complicated with iritis.

6. *Traumatic iritis* is met with after penetrating wounds of the cornea and iritis, sometimes after cataract or other operations on the eye. It presents nothing peculiar in its symptoms.

We have to remember as rare causes of iritis, prolonged overwork of the eyes, and scrofula; while some cases cannot at present be explained by any known cause. It is important to bear in mind the great difference which exists in the severity of the symptoms in different cases. The term "quiet iritis" is used when pain and congestion are wholly absent; it is generally due either to inherited gout or syphilis, but may arise from almost any other of the causes mentioned.

Results of Iritis.—If a severe case of iritis is neglected,

blindness is liable to result from the blocking of the pupil with lymph (occlusion), or from the formation of a total posterior synechia (exclusion). In the latter case, the fluid in the two chambers does not circulate and escape in the normal manner; the outer part of the iris becomes bulged forward, and secondary glaucoma may supervene. Even if thoroughly treated, iritis will probably leave slight impairment of vision owing to uveal deposit on the lens, etc., but in most cases the recovery is almost perfect. The most obstinate forms are serous iritis, that due to inherited gout, and sympathetic iritis.

Treatment.—In all cases without exception use atropine so long as the attack is in an active stage. A solution of four grains to the ounce should be applied (two or three drops) every two hours the first day or two, and less frequently afterward if the adhesions yield. The strongest known mydriatic is a combination of atropine and cocaine (two per cent), and the surest way of having it thoroughly applied is to use them in vaseline (the purest), inserting a little of the ointment within the lids. Occasionally atropine irritates, increasing the congestion, and causing some swelling of the lids and eczema around them. These cases are very exceptional; in them sulphate of daturine (four grains to the ounce), or sulphate of duboisine (one grain to the ounce) may be tried instead of the atropine. After an attack has wholly passed off it is worse than useless to persist with mydriatics in the hope of breaking down old adhesions, as they may then produce irritation and congestion of the eye.

In cases of syphilitic iritis, the patient should be brought thoroughly under the influence of mercury, either given internally (hyd. c. cretâ, two grains; pulvis ipecac. comp., one grain, thrice daily in pill; by calomel or blue pill, or the liquor. hydrargyri bichlor, in one-drachm doses), or by inunction, subcutaneous injection, etc. Of these methods, probably the internal administration of gray powder is the most convenient and as efficacious as any. If the gums become touched, the dose of mercury should be diminished, and chlorate of potash used as a mouth-wash.

Of course stimulants should be forbidden, and the eyes should be kept at rest by means of a shade or confinement to a darkened room. In serous iritis, or where one eye only is affected, however, the latter measure is unnecessary.

In rheumatic iritis, the application of warm dry heat, by means of cotton-wool and bandage, is of value; while in traumatic iritis, cold should be used by means of small ice-bags etc. This is the only form of iritis in which cold should be employed. When the rheumatic or "arthritic" tendency is present, iodide and bicarbonate of potassium may be given; in gouty iritis vinum colchici may do good. In serous iritis with anæmia give iron and cod-liver oil, and endeavor to improve the general health as far as possible. In the obstinate cases of relapsing irido-cyclitis due to inherited gout, probably nothing will be found to effect a cure except change of climate (a warm dry one, such as some parts of New Zealand, being the best).

In acute iritis, with severe pain, the latter is generally relieved to some extent by atropine, but belladonna fomentations (one drachm of the extract to a pint of warm water) are also of use. If, in spite of these measures, the pain persist, blistering the temple should be tried (some authors recommend leeches), and morphia or chloral may be required at night-time in order to obtain sleep.

A brisk purge is advisable in commencing the treatment of acute rheumatic or syphilitic iritis.

If, in spite of treatment, many firm adhesions remain, and especially if complete posterior synechia, with increase of tension, be present as the result of iritis, there is no question that an upward iridectomy should be performed. The operation, however, is often rendered difficult by the iris having become soft, or "rotten," as well as by the fact of the adhesions, and sometimes the artificial pupil becomes again closed by firm lymph. It used to be thought that adhesions in themselves led to relapses of the iritis, and that to prevent the latter an iridectomy was necessary, but this view is now doubted. However, it is quite justifiable to perform the operation in cases of rheumatic iritis in which relapses are frequent, and it would seem to have some influence in preventing them, as well as exclusion and occlusion of the pupil. Iridectomy, however, should not, as a rule, be performed on an eye so long as it is inflamed, but in an interval between the attacks. In cases of old iritis and interstitial keratitis, too, it is sometimes followed by an improvement of vision, especially if the artificial pupil can be formed behind a comparatively clear part of the

ea. Here again, however, the operation should not be done
the eye is inflamed, but only when the adhesions of the
nd the corneal opacities are obviously permanent.

umors of the Iris.—The iris, like other parts of the uveal
is occasionally the seat of melanotic sarcoma; curious
formations have also been met with, and tuberculosis of
ructure is not unknown. These affections are too rare
e further notice here, but it is worth bearing in mind
le gummata due to inherited syphilitic iritis have,
diagnosis of tubercle.

CHAPTER V.

CATARACT.

It is most important to recognize the different forms of cataract, since they vary greatly in prognosis, some steadily advancing to complete opacity of the lens, others remaining absolutely stationary. In all cases where cataract is suspected the eye should be examined by oblique focal illumination; the fundus should be explored with the ophthalmoscope so far as is possible, and in cases of partial opacity of the lens the best view of it will be obtained (after dilating the pupil with homatropine) by using a magnifying lens of 12 D to 20 D in the ophthalmoscope and carefully focussing.

With the advance of age the lens becomes harder, less elastic, and yellow; in some cases a cataract may be suspected at first by using only oblique illumination—the ophthalmoscope proving that none exists, by the perfect view of the fundus that is obtained. If the opacity commence about the centre of the lens it is called a nuclear cataract; if at the periphery, a cortical one. Nuclear cataracts generally occur in old patients (senile form), as do many cortical ones, but a large proportion of the latter develop at an early age. Cases of cataract come under one of two groups: the hard form, for which extraction is the only operation, and the soft, for which operations involving absorption by means of the aqueous humor (needling, suction, etc.) are performed. Roughly speaking, cataracts occurring under the age of thirty or thirty-five are of the soft variety.

1. *Senile Cataract.*—Is commonly seen after the age of forty-five or fifty. No cause can generally be assigned; it has, however, been stated that a considerable number of the patients present atheromatous changes in the carotid vessels, or other evidence of impaired circulation (Michel). As already noted, it may commence in either cortex or nucleus, commonly

the latter. The first symptom is dimness of vision, especially in the distance; sometimes the near vision is at first unusually acute, owing to the development of slight myopia. The patient may complain of seeing two or more images with the affected eye (monocular diplopia) when the changes are incomplete. The rate of progress is very variable; usually one to three years elapse before the cataract is mature or ripe, though some cases are very much slower; as a rough rule, a senile cataract advances most rapidly in a comparatively young patient (*e.g.*, forty to fifty years old).

Varieties.—A Morgagnian cataract is one in which a very hard nucleus is surrounded by liquid or very soft lens matter, and is nearly always an over-ripe one.

A "black cataract" is very rare; the lens is universally hard, and dark brown color; it is less easily detected by direct illumination, and the patient usually retains more vision when it is complete than in the ordinary yellowish-white or white form (*i.e.*, he can count fingers held at the distance of a few feet). An "atrophic cataract" is due to shrinking, and sometime calcification of a lens which has been opaque for many years; it is most unfavorable for operation.

Prognosis of Operation for Senile Cataract.—Taking the statistics of the modern method of extraction, it may be said that usually 5 per cent (1 in 20) are complete failures, owing to suppuration, severe iritis, etc. A considerable number of the 95 per cent of successful cases do not attain perfect sight after the operation, owing to persistent irritability of the eye, irregular astigmatism, slight iritis, etc. And in a few cases sympathetic inflammation of the other eye follows an apparently successful extraction. As a general rule a senile cataract should not be operated on until it is ripe, and until the opacity is so great in both eyes that the patient can no longer see to do his work; one eye should only be operated on at a time, and operations should be avoided, if possible, in very old and feeble patients, and during extremely hot or cold weather. It is most important to remember that the existence of a muco-purulent discharge (generally from chronic inflammation of the lacrymal sac) will almost certainly lead to suppuration after cataract-extraction, and hence the operation should never be undertaken until the inflammation is cured by appropriate treatment.

The following are forms of cataract which are more or less unsuited for operation, or in which a perfect result cannot be expected:

1. Secondary cataract—after iritis, glaucoma, etc. In highly myopic patients with cataract the vitreous is often abnormally fluid, and there may be detachment of the retina, or other degenerative changes.

2. Diabetic cataract. Here everything depends on the patient's state of health; if he has lost much flesh, is affected with lung disease, or if the quantity of sugar in the urine be very large, no operation should be undertaken.

3. Cataract in a lens dislocated by injury. If operated on, the scoop will have to be used, and more or less escape of vitreous (from previous rupture of the suspensory ligament) must inevitably follow.

4. Anterior polar (pyramidal) cataract. (See Fig. 1. Pyramidal cataract is left by an attack of ophthalmia neonatorum.) The opacity is very small, and, as a rule, remains stationary, and requires no treatment. Similarly no case of cataract should be operated on if the opaque parts are so limited as not to prevent the patient retaining fair vision.

When is a Case of Senile Cataract ready for Operation?—As a rule, one eye fails before the other, and so long as the patient sees well enough to do his work, etc., with the best eye, it is wise to defer operating on the other. For, apart from the slight risk of sympathetic ophthalmia following the operation, supposing that all goes well, the operated eye will of course require a strong convex glass, and the image formed on its retina will be of a different size to that formed in the other eye, and hence binocular vision cannot be well carried out. Supposing the cataracts to be so advanced that the patient can no longer see to do his work (in fact, is practically blind), the following tests should be tried before deciding upon operation: 1. Examine by focal illumination. If the opacity comes forward to the iris, if the latter throws no shadow on the lens, then the cataract is probably mature.

2. Throw a strong light suddenly on the eye, the other being covered; the pupil should contract to the illumination.

3. The patient should have distinct perception of light, should know when the eye is shaded or not.

4. He should have fair peripheral vision, *i.e.*, in a dark

room, when looking straight forward, he should be able to tell the position of a lighted candle when moved about in different positions at the distance of several feet from his eye.

NOTE.—In some cases of very slowly advancing cataract, the sight being greatly impaired, a preliminary iridectomy may be done upward, and extraction performed later. The same applies to cases in which special risk or fear of complications exists (*e.g.*, myopic cases; or those in which the other eye has previosuly been operated on with complete failure).

2. *Traumatic Cataract.*—If the lens capsule is wounded by a penetrating instrument, as a rule the whole lens becomes opaque within a few days, owing to the soaking in of the aqueous humor. The lens matter swells and protrudes more or less into the anterior chamber. Iritis is very liable to occur, and the pupil should be kept dilated with atropine. Should, however, the tension rise and the eye become painful, owing to the rapid swelling of the lens, it is best to make a corneal section with a narrow keratome (usually on the outer side of the eye); introduce a curette just within the wound, and let out as much of the white matter as will come. Ice or iced water continually applied over the closed lids is a useful adjunct to the atropine, which should be used three or four times a day, until all trace of iritis has subsided, whether any operation is performed or not. If the cataract is gradually absorbed by the action of the aqueous, the pupil will nearly always remain blocked by the remains of opaque capsule and lens matter; but, provided the patient can see well with the other eye, it is best to leave this alone, since an operation done for appearance' sake on such an eye is by no means free from risk of causing (1) inflammatory or suppurative changes in the eye itself, (2) sympathetic mischief in the other one.

Concussion cataract is a form of traumatic cataract, in which the opacity of the lens (generally extremely limited, and dotted opacity on the anterior or posterior pole) is due to a blow on the eye (*e.g.*, with the fist), without penetrating wound of the cornea. It is probable that in most of these cases the capsule is very slightly ruptured. Of course, being usually opposite the centre of the pupil, these small opacities may considerably interfere with vision; but the rest of the lens may remain quite clear, and no treatment is then indicated. In other cases the opacity slowly invades the rest of

the lens; an operation may then be called for, owing to the cataract interfering with the patient's work, etc., and will consist either in needling in young subjects, or extraction in old ones.

3. *Lamellar cataract* (synonym, Zonular c.).—The nucleus and cortex of the lens are clear, but between them intervenes a layer (lamella) of opaque matter, with, in most cases, little spicules projecting into the clear peripheral part. This peculiar form of cataract is either congenital, or comes on soon after birth; affects both eyes, and does not tend to spread to the whole lens. Its subjects have in nearly all cases been liable to convulsions in infancy, and present peculiar malformations of the permanent teeth. These (especially the incisors and canines) are more or less dwarfed or grooved horizontally. It is held that this horizontal wearing away of the enamel is due to the mercury which has been given for the convulsions (Hutchinson). The amount of visual defect in a patient with lamellar cataract varies much; as a rule it is

FIG. 13.—Cataract-needle. (The end is represented too wide.)

only noticed when the child begins to learn to read. Occasionally its subjects are mentally defective. To see the cataract properly the pupil must be dilated, when the white circle with the little projections of opacity are seen by focal illumination, or by using the ophthalmoscope. The patient sees better when the pupil is dilated, since then the rays can pass through the clear part of the cortex, and in attempting to read, etc., he holds the object near to the eye, in order to compensate by the increased size of the image for its want of clearness.

Treatment.—If the vision is sufficiently good to enable the patient to read moderately well (*e.g.*, $\frac{6}{18}$ and 4 J.), no operation should be performed. But in most cases either an iridectomy or the needling operation is required; if the use of atropine much improves the vision, the former should be done (downward and a little inward); if not, the latter. Here may be described the chief operations for soft cataract:

1. Simple needling. The pupil is to be well dilated with atropine; a speculum introduced, or the lids held open by the fingers, and a sharp cataract-needle inserted obliquely through

periphery of the cornea and into the lens at the centre of pupil. The needle-point is moved about so as to tear the sule and part of the lens, and then quickly withdrawn, fully avoiding touching the iris. Atropine is again ap- l. with ice, for a day or two.

e lens matter imbibes the aqueous, swells up more or and is gradually absorbed. At the end of six or eight the needling will probably require to be repeated, and imes the case will need three, four, or even more opera- tough opaque capsule, which is sometimes left at the ing either torn with two needles, or cut across with De r's special scissors, introduced through a small periph- rneal wound.

tedious, but, as a rule, very safe method of treating aracts, may be replaced by:

tion. In this method a fi needling is performed; keratome or broad cutti edle introduced through rnea on the outer side, through this wound the of a special forr passed into the lens, and taract ge lar after-treatment.

A curette is used instead of th syringe, and by pressure exerted with the index-finger the soft lens matter is squeezed gently out along the curette, the end of which is introduced just within the anterior chamber. This operation should be performed after a free needling has caused the lens matter to swell up and soften.

CHAPTER VI.

GLAUCOMA.

THE essential feature of this disease is an increase of tension of the globe, due to obstructed filtration of fluid from the eye, and possibly to hyper-secretion within it. In the normal eye there is a constant filtration of fluid from behind forward through the suspensory ligament of the lens and part of the ciliary processes and iris into the angle of the anterior chamber, the spaces of Fontana and the canal of Schlemm. Thus a sort of equilibrium is kept up, the tension of an eye, however, varying very slightly from time to time. Any obstruction to the outflow, either from inflammatory changes at the ciliary angle, from increase in size of the lens (which Priestley Smith has found to occur as age advances), or from congestion about the ciliary region, impeding the escape into the blood-vessels, is liable to set up glaucoma. Further, glaucoma is more common in eyes with a firm unyielding sclerotic (elderly patients, especially those previously hypermetropic) than those with a yielding one (myopic eyes). If glaucoma comes on apparently spontaneously it is called primary (nearly all cases of acute glaucoma are primary); if following some other disease of the eye it is said to be secondary. Among the causes of secondary glaucoma are: 1. Traumatic cataract, in cases where the lens swells up rapidly. 2. Dislocation of the lens, where it presses on the ciliary region. 3. Severe iritis, followed by occlusion or exclusion of the pupil. 4. Intraocular tumors. 5. Cyclitis (inflammation of the ciliary region); or irido-cyclitis, such as is occasionally due to inherited syphilis. 6. Sympathetic ophthalmia.

Glaucoma is divided into the acute and chronic forms, typical cases of which differ extremely; but intermediate stages are met with, and it is not uncommon for a chronic case to have acute, or subacute, attacks. Acute glaucoma

is much more common among women than men, and about 75 per cent of the total number of glaucoma cases are met with between the ages of forty and seventy years, so that glaucoma is chiefly a disease of advanced adult or old age.

Predisposing Causes of Primary Glaucoma.—1. An inherited tendency is observed in some cases. 2. The advance of life; we may almost speak of the period after forty years of age as the "glaucomatous period;" this may be connected, perhaps, with the increase in size of the lens (Priestley Smith). 3. Excessive use of the eyes, leading to congestion; prolonged strain, as in night-nursing, etc., grief, or mental emotion (especially if the patient weeps or "frets" much) or sudden mental shock, are all circumstances which may bring on an attack in a patient predisposed to glaucoma. 4. There is certainly a connection between gout and glaucoma, and it will be found that acute glaucoma is especially frequent in the autumn, as the cold weather comes on, and the patient's change of diet and habits renders him liable to an attack of either acute gout or glaucoma. 5. The use of atropine in elderly patients (and even of homatropine) has occasionally been followed by acute glaucoma, and hence it should be avoided if possible. The reason is to be found in the atropine causing the iris to obstruct filtration by forcing it up into the angle of the anterior chamber.

Symptoms of Acute Glaucoma.—Often there are premonitory signs, of which the following are the most important: rapid increase of presbyopia, attacks of passing congestion, pain and dimness or "fogginess" of vision, haloes (colored rings) seen when looking at a distant light. Finally, acute glaucoma develops, the vision becomes suddenly much worse (all degrees up to complete blindness), there is very severe pain in the eye and head, with frequently a feeling of sickness or actual vomiting, and the eye presents the following features: Congestion of the globe and lids, with, perhaps, chemosis; dimness or steaminess of the cornea and aqueous, which obscures the iris, etc.; pupil moderately dilated and fixed, or acting but very slightly to light or shade; if the fundus can be seen there is a depression (cupping) of the whole disc; the veins are engorged, and there is arterial and venous pulsation, and the tension is raised (often the globe cannot be indented at all, then $T = +3$). The cornea is frequently anæsthetic.

The visual field is found to be much narrowed, its inner side going first, and the patient generally himself notices this narrowing, being unable to see objects unless held in a line with his eye. If the loss of vision is almost complete, the narrowing of the field may still be recognized by moving a lighted candle in front of the patient as he looks straight forward. The lens looks turbid, or grayish, and not uncommonly, in acute glaucoma, no view of the fundus at all can be obtained. The anterior chamber is generally very shallow, but this is not constant.

Diagnosis.—The importance of remembering the signs given above is very great, as an error of diagnosis is often made during the first few days, when immediate treatment can alone be expected to restore the sight. The headache and sickness may be thought to indicate merely a "bilious attack;" or the congestion and dimness of the media may be held to show "iritis," and atropine used with disastrous effect; finally, the chemosis and slight watery discharge may lead to the diagnosis of "acute conjunctivitis." The one essential test is the estimation of the eyeball tension.

Treatment.—May be summed up in one word—iridectomy. In a severe acute case the necessity should be urged on the patient of an immediate operation, which should be performed under an anæsthetic if possible, the wound being made peripheral in the upper part of the sclero-corneal junction, and a considerable piece of the iris excised (see Operations—Iridectomy, page 411). The pressure on the retina and optic nerve tends to completely destroy their functions, and hence, after acute glaucoma has existed some time, sight will not be regained, even if the tension and pain are lessened by an operation. The urgency for the latter in acute glaucoma is as undoubted as in strangulated hernia.

If, however, the patient will not consent to an operation at once, or if the attack is a subacute one, and has, perhaps, occurred before, eserine should be used. A solution of two grains of eserine to the ounce of water (to which cocaine may be added—two per cent) should be applied very frequently, and the eyes should be protected from light. Pilocarpine (four grains to the ounce), like eserine, diminishes tension and contracts the pupil, but its effects are less marked as a rule. Paracentesis of the cornea (pricking it toward the lower bor-

der with a broad needle and letting out the aqueous humor) is of temporary use. Turpentine, given internally (half-drachm to one-drachm doses in emulsion three times daily), is recommended by some. Of these adjuvant measures the use of eserine is the most important, but all of them are quite secondary in obtaining a cure to early iridectomy.

Prognosis.—The rapidity with which complete and permanent blindness comes on in untreated cases varies much, and so long as there is some sight left in a case of acute glaucoma iridectomy should be tried. But when it has been wholly lost for some time, the operation will, as a rule, merely relieve the pain, etc., if it is still complained of.

If done early and freely (the incision being placed as far back as is safe) the results are generally very good. The patient may regain perfect vision (although some astigmatism, resulting from the operation, may need correction), and the tension remain normal, partly, no doubt, owing to the filtration which occurs through the thin scar.

In a few cases free retinal or vitreous hemorrhages follow the sudden relief of tension by iridectomy; in a few others the lens is wounded during the operation (if a keratome be used) and cataract ensues; there is an appreciable risk of staphyloma and of sympathetic ophthalmia after the operation; and in some the glaucomatous symptoms recur. If the latter happens, or if the tension remains rather full, a careful trial of eserine may be made; and if this fails a second iridectomy may be made, or what is known as sclerotomy performed. In sclerotomy the incision is made with a Graefe's knife, in the same position as an iridectomy, but the conjunctiva is only divided at the points of puncture and counter-puncture, and no iris is removed. It is even more difficult to perform well than iridectomy.

Symptoms of Chronic Glaucoma.—The congestion of the conjunctiva and sclerotic is comparatively slight, or may at times be quite absent; but if it has existed for long there is a grayish-blue ring seen just behind the cornea, due to thinning of the sclerotic, and there may be slight bulging at this spot.

The media are usually perfectly clear, so that a good view of the fundus can be obtained (the lens, however, tends slowly to become cataractous); the pupils react to light (but often sluggishly), so long as the sight is retained, and there may be

very little pain during the progress of the disease. The tension of the globe varies much from time to time, and the anterior chamber may be deeper than normal. The two most diagnostic symptoms are the state of the disc (cupping, sudden bending of the vessels as they emerge from the disc, venous pulsation, and sometimes arterial, especially on slight pressure on the globe, grayness of the nerve from atrophy), and the narrowing of the visual field (as taken with a perimeter). With regard to the latter, the field for white may be concentrically narrowed; its inner part may be limited or absent, or there may be considerable irregularity in the outline.

Vision, both near and distant, tends steadily to deteriorate, though in some cases many years may elapse before it completely goes, and in a few it remains stationary for long. Rainbow-rings seen round a distant light, throbbing in the globe, headache, and attacks of "mist before the eyes," are frequent symptoms. The most prominent differences between acute and chronic glaucoma may be recapitulated in a table:

	ACUTE GLAUCOMA.	CHRONIC GLAUCOMA.
1. Conjunctiva, etc...	Great congestion, perhaps chemosis.	Congestion slight or absent; bluish circumcorneal ring in old cases.
2. Cornea.....	Steamy, anæsthetic....	Clear.
3. Iris.....	Pupil dilated and fixed.	Pupil normal, or rather sluggish, and slightly dilated.
4. Anterior chamber..	Shallow.....	Generally normal or deep.
5. Disc.....	Media often too heavy to see through; disc found cupped somewhat, and arterial pulsation present.	Media clear; deep cupping and whiteness of the nerve; pulsation marked as a rule.
6. Field, etc.....	Vision rapidly lost; field extremely limited.	Field more or less limited; central vision may be good.

Treatment of Chronic Glaucoma.—An operation is far less successful in this form; nevertheless, a free upward iridectomy may be done if the sight is steadily deteriorating in spite of treatment, or if an acute attack supervenes. It may be expected to result in the patient at least retaining what vision he had before the operation, and sometimes it improves it.

The avoidance of anything likely to cause congestion of

the eyes, careful attention to the patient's health (avoidance of stimulants and regulation of diet if gout be present), and the long-continued use of weak eserine drops (½ to 2 grains to the ounce, applied once or twice daily), or of pilocarpine, are the chief measures of treatment. In some cases the patient is obviously anæmic, or out of health, and tonics may do good. The bowels should be kept regular in action.

Prognosis.—As a general rule, the younger the patient the worse the prognosis. As regards iridectomy, those cases in which the pupil contracts well on using eserine are much more favorable for operation than those in which it acts very little or not at all.

The prognosis of secondary glaucoma is worse than that of primary on the whole, and some cases (*e.g.*, due to tumor, old dislocation of the lens, relapsing cyclitis) can only be treated by excision of the eye.

In both acute and chronic glaucoma, if one eye has been affected there is considerable risk of the other becoming glaucomatous also, and a good many cases are symmetrical from the first.

CHAPTER VII.

INJURIES TO THE EYE.

WITH the various forms of injury to the eye and their treatment the student should be thoroughly familiar, as they are very often met with in practice. We may consider them under the following heads:

1. *Burns and Scalds.*—In recent cases of burn or scald of the lids it should be ascertained as soon as practicable whether the globe has escaped injury or not. Some non-irrritating ointment should be applied between the lids from day to day, and if there is much discharge syringing gently with boracic lotion is advisable, if conjunctivitis persists a mild astringent (two grains of sulphate of zinc or of nitrate of silver to the ounce) should be used. If there is much swelling of the lids, continuous cold applications give relief, and may save the eye.

If, however, the cornea has been severely injured, and subsequently slough, enucleation may become necessary. Burns of the conjunctiva, especially if due to caustic lime or strong acids, are almost certain to be followed by adhesion between ocular and palpebral layers (symblepharon), which in a few cases may be subsequently relieved by operation. But the great risk of such injuries is to the cornea, which is seen to be whitened and dim when the lids are separated. The opacity rarely clears, indeed, it generally becomes worse, and a most guarded prognosis should be given. The irritant should be completely removed by syringing with a weak acid or alkaline solution (depending on the nature of the caustic which has inflicted the injury), and castor-oil should be dropped in, or the ung. acidi boracici used for several days, the eye being lightly bandaged meanwhile. Pure cocaine (not its salts) will dissolve in castor-oil, and may relieve the pain if so applied after a burn of the conjunctiva.

Foreign Bodies.—Small sharp objects often become firmly

fixed in the cornea. If not readily seen by daylight carefully examine with the aid of lens and artificial illumination. Apply 2-per-cent solution of cocaine, until the conjunctiva is insensitive, and then, standing behind the patient, remove the foreign body with a small spud, or (if firmly imbedded) with a mounted needle. If a piece of steel or iron has been fixed for some time a ring of rust will remain after it has been extracted; this can easily be removed. Bandage the eye up for twenty-four hours, and if the irritation is severe use atropine and compress. The removal is rendered easier by gently fixing the globe with the left index-finger, pressing through the lower lid. If "something has gone into the eye," and it is not found on the cornea or conjunctiva, look for it in each upper fold, everting the upper lid, and making the patient look upward, in order to expose the upper fold. It is very often found on the inner surface of the upper lid. Sometimes a foreign body of considerable size (*e.g.*, an insect) has travelled under the upper lid and set up conjunctivitis without the patient being aware of the cause of his trouble, the conjunctivitis existing, of course, of one eye only, and thus exciting the surgeon's suspicion of its cause.

Occasionally an eyelash becomes fixed in one of the puncta lachrymalia, and sets up much irritation; in these cases the congestion being greatest on the inner side of the globe will attract attention.

A foreign body, especially a chip of iron or steel, is sometimes driven almost through the cornea, so that its end projects into the anterior chamber; it is then impossible to remove it by the ordinary way, and a broad needle must be entered toward the edge of the cornea, and its end used to press up the foreign body, while the wound is enlarged and the foreign body extracted. This operation requires much care, and it is perhaps best to give an anæsthetic before it is attempted. The foreign body may be driven right through, so as to rest in the anterior chamber, or to be fixed in the iris or lens. To remove it a small corneal section should be made, and the canula or fine iris-forceps used. If of iron, the foreign body may be removed by the fine point of an electromagnet introduced through a corneal wound. If the lens capsule has been wounded cataract will certainly follow; for its treatment see "Traumatic Cataract" (page 376). If fixed

in the iris a small piece of the latter may be excised, bringing with it the foreign body. It should be remembered that the patient is often quite mistaken about the size of the foreign body, and that the wound of entrance is often difficult to find. I once removed a steel needle two-thirds of an inch long, which had traversed the lens and vitreous, and become fixed in the sclerotic; the blunt end only showed in the anterior chamber, and the patient described the bit of steel as "very small." If there is any doubt as to penetration by a foreign body, and it cannot be seen on examination, homatropine should be used and the fundus thoroughly explored. Fragments of iron have often been removed from the posterior part of the eye by means of an electro-magnet point introduced through a wound of the sclerotic, and sometimes with complete success, but unfortunately in most cases inflammation supervenes and vision is much deteriorated. Suppuration may follow penetrating wounds of the cornea or sclerotic, especially if some septic or

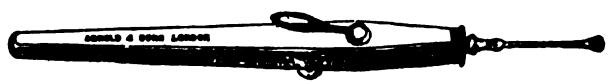

Fig. 14.—Canula-forceps.

dirty matter is introduced, and there is hardly any limit to the variety of foreign bodies which are occasionally imbedded in the eye. Bits of glass (from bursting of bottles) and shot are common ones; in one case I excised an eye, the anterior chamber of which was half full of brick-dust. Air-bubbles in the vitreous after wound of the sclerotic are occasionally seen, and are somewhat difficult to distinguish from fragments of iron, etc.

If, in spite of treatment, the eye inflames severely, so that sight is lost, and especially if a foreign body is believed to be still in the globe, excision should be performed.

Abrasions of the Cornea.—Minute scratches of the corneal epithelium give rise to intense photophobia and lachrymation; they are sometimes seen in women nursing infants, and due to the latter's fingers. Hypopyon-iritis may be set up, and, in elderly people, many cases of serpiginous ulceration (see page 345) are started by an abrasion of the cornea.

Continuous warm belladonna fomentations, with cocaine (ten grains to the ounce of castor-oil or vaseline), form the

appropriate treatment until the abrasion is repaired. If iritis supervene, atropine must, of course, be used.

Contusion or Concussion Injuries.—As is well known, in most cases of "black-eye" the globe itself escapes injury. The best method of procuring rapid absorption of the ecchymosis is to apply ice (or an evaporating spirit lotion) at first over the closed lids, and after twenty-four hours or less to use warm fomentations. After extensive ecchymosis of the ocular conjunctiva, the iris may be for a time discolored or stained in part; or "traumatic mydriasis" may be present for a few days. In this condition the pupil is dilated, and does not act on stimulation, or only very slightly, and the power of accommodation may be lost. Vision may at the same time be impaired from concussion of the retina without perceptible injury, perfect recovery ultimately ensuing. But more serious damage may be done by a blow on the front of the globe, the following lesions resulting in some cases:

1. Rupture of the eye, with, frequently, escape of the lens and some of the vitreous, either under the conjunctiva or through the wound. The rupture is nearly always at the thinnest part of the sclerotic—that is, just behind the cornea, and often involves the latter. The tension of the globe is much lessened; excision is the only treatment.

FIG. 15.—Rupture of Globe, with Dislocation of Lens inward (beneath conjunctiva).

2. Dislocation of the lens, partial or complete. This should always be suspected if the iris remains tremulous on rapid movements of the eye; or if one part is pushed forward and another depressed. Secondary glaucoma is very likely to follow if the eye is not excised.

3. Hemorrhage into the vitreous or retina; the former can be detected as dark floating masses with the ophthalmoscope. They may be largely absorbed, but vision is nearly always much impaired. Hemorrhage into the anterior chamber is rapidly and completely absorbed.

4. Rupture of the retina or choroid at the posterior pole of the eye, by contre-coup.

5. Opacity of the lens, partial or complete. See Traumatic Cataract.

6. Dark pigmentary changes in the retina, with more or

less atrophy of the optic nerve, may come on after a blow on the eye; they also are most marked in the central region.

7. Detachment of part of the iris from its ciliary origin ("coredialysis"). There is no reason to advise excision after injury followed by the conditions 3 to 7, since some useful vision may be retained, and there is no risk of sympathetic ophthalmia.

Penetrating Wounds of the Eye.—Cleanly-cut wounds of the cornea unite rapidly, but with some impairment of vision in most cases. Wounds of the sclerotic and conjunctiva may be sutured with very fine silk, a mild antiseptic dressing being subsequently employed. It is, however, unnecessary to sew up small wounds in the sclerotic; they unite well if gentle pressure be maintained on the eye by means of pad and bandage, after ice has been applied for a day or two, if possible. Wounds of the sclerotic at some distance from the cornea are less serious than those involving the "dangerous area"—*i.e.*, for a quarter of an inch immediately behind the corneal margin. Inflammatory changes following wounds in this part (which corresponds to the ciliary processes) are extremely liable to be followed by sympathetic ophthalmia. Hence, if after such injuries sight is completely or almost completely lost (*e.g.*, if only perception of light is retained), there can be no question that immediate excision should be performed. If, however, a wound of the ciliary region is not followed by much impairment of vision, the question of treatment becomes very difficult. Excision should be advised, even if the wound of the ciliary region be small, if severe iritis follow; and if it is probable that a foreign body is imbedded in this region the operation is especially indicated.

In the case of recent wounds of the cornea, with prolapse of the iris, an attempt should be made to push back the protruding part with a small spatula; if this fails the iris should be slightly drawn out and cut off (see Iridectomy, page 410). Eserine should subsequently be used, unless iritis supervene, in which case atropine and ice should be employed.

It will have been seen that the danger of an injury to the eye is not always confined to the eye itself; but that, within an almost unlimited period (but very rarely before three or four weeks have elapsed from the date of injury), the other one may become affected. We have to consider: (1) Sympa-

thetic irritation, and (2) Sympathetic inflammation, or ophthalmia. Either of these two is especially likely to follow a penetrating wound of the dangerous or ciliary region, but in rare cases have developed after perforating ulcer with iritis or cyclitis, or even intraocular tumor. They may occur at any age, the usual period being between six weeks and six months after the injury.

Sympathetic Irritation.—Attacks of congestion and watering of the eye, failure of accommodation (shown by sudden dimness of the print), neuralgia of the globe or head, disturbance of vision, floating bodies seen before the eyes, etc., and irritability on exposure to moderate light, are the chief symptoms. These may recur repeatedly, and in most cases they do not indicate threatening sympathetic inflammation. If the exciting eye be excised the symptoms do not, as a rule, recur; hence, if the injured eye be still more or less inflamed, painful, and the vision bad, excision should be advised. For though sympathetic irritation does not apparently often pass on to sympathetic inflammation, we can never tell in which case it may happen to do so.

Sympathetic Inflammation.—Most cases of this terrible disease are essentially ones of plastic iridocyclitis, in which tough adhesions are formed to the lens, which becomes opaque, and the vitreous and retina may be secondarily involved.

Pathology.—The method of transmission from the exciting eye to the sympathizing one is quite doubtful, the chief theories to explain it being:

1. Germ-transmission through the circulation.
2. Lymphangitis travelling from one eye to the other, especially along the optic-nerve sheath.
3. Spreading neuritis by way of the ciliary nerves.

Free cellular exudation into the ciliary process, iris, choroid, and sometimes into the anterior chamber ("serous iritis," see page 368), is the chief feature in the pathology of sympathetic ophthalmia. Optic neuritis is present in many cases. The disease sometimes is recovered from with fair retention of vision (the cases of sympathetic serous iritis are the mildest, and occasionally leave hardly any defect of sight). But the prognosis of most cases of sympathetic ophthalmia is extremely bad; the pupil becomes occluded by tough lymph, the iris universally adherent, the lens cataractous, and vision

may be completely lost in the course of a few weeks or months.

Treatment.—Complete rest of the eyes in a dark room, mercurial inunction, extract of belladonna given internally, counter-irritation to the temple, atropine frequently applied to the eye. Or mercury may be given by the mouth, with belladonna and quinine, but the effect of internal treatment is rather doubtful. It is, of course, essential to use atropine if the case is seen fairly early; after tough adhesions have been formed it is quite useless.

It might be thought that the exciting eye should at once be excised; but, unless it is absolutely blind, it is perhaps wiser not to remove it, as ultimately it may retain the best vision of the two. No operation should be done on the sympathizing eye until the inflammation has quieted down, and then a free iridectomy (with extraction of the lens, if that is opaque) may do good, though it is to be feared that the aperture formed will become closed again by lymph. Operative interference should, of course, be avoided if any useful sight is retained.

CHAPTER VIII.

...SES OF THE OPTIC NERVE AND RETINA.

...*Neuritis.*—Inflammation of the optic disc, "papilli-... ...aracterized by hyperæmia, swelling of and exudation ...e disc, with more or less involvement of the surrounding ...(...pecially the anterior or nerve-fibre layer). It is di- ... ...ophthalmoscopically by blurring of the disc-margin, ...lly some radiating striation, and in some cases ...asations of blood; the abrupt bend of the vessels ...llen edge of the papilla, and by their tortuosity, ...obscuring of the former by lymph, etc. The top ...the optic ... can be best seen with a + lens in the ophthal-moscope, and supposing the patient to be emmetropic, the degree of swelling may be measured by the highest convex lens with which the details can be made out. Accompanying retinitis is indicated by a haze of that part of the fundus nearest the disc, by the presence of whitish streaks, dots, or patches, especially in the neighborhood of the yellow-spot, by perivascular lines of white color, and by hemorrhages, generally linear or flame-shape.

The whitish patches alluded to are due to œdema of and exudation into the retina, and may clear off to a large extent, though they generally persist for long; the hemorrhages may also be absorbed (leaving often small black spots of pigment to mark their existence), and the inflamed nerve itself tends in most cases to become more or less atrophic.

Atrophy of the optic nerve is diagnosed by the abnormally white hue of the disc; sometimes by the shrinking of the arteries, and to a less extent of the veins. If it is a result of inflammation ("post-neuritic") there is usually some irregularity and pigmentation of the border of the disc, and fine white lines along the vessels are not infrequently seen; further minute changes at the yellow-spot exist in a large proportion of

the cases. Sometimes, however, atrophy of the optic nerve is primary, that is, not preceded by neuritis, and then the abnormal whiteness of the disc is the chief, and sometimes the only, ophthalmoscopic sign.

Symptoms.—Rapid failure of sight (both near and distant), with blurring of objects, is frequently complained of in acute neuro-retinitis, but it is most important to remember that severe optic neuritis may exist without any defect of vision whatever. More or less headache and pain in the back of the eye, sometimes photophobia, irregular limitation of the field of vision (as tested with the perimeter), a similar defect of color-perception, imperfect action of the pupils to light, and the defect of vision being especially marked toward evening or in a dim illumination, are all symptoms which may or may not be present in an individual case.

Gradual failure of sight (especially in the evening), contraction of the field of vision, with more or less color-blindness (especially defect for red and green), are the chief symptoms of optic atrophy or of slowly progressing optic neuritis.

1. *Causes and Forms of Optic Neuritis.*—Cerebral tumors, gummata of the meninges or brain, cerebral abscess, and meningitis (tubercular, traumatic, etc.) are frequent causes of double optic neuritis. This is often pure papillitis, but in some cases the changes in the retina (hemorrhages and white patches) are just as extensive as in renal retinitis (see No. 3). In the case of neuritis due to tubercular meningitis, tubercular nodules are occasionally developed in the choroid and retina, some way from the disc.

Optic neuritis (slight and soon clearing off) is seen in a few cases of severe concussion of the brain, and optic atrophy (probably from rupture of the optic nerve or hemorrhage into its sheath) may occur on one or both sides after fracture of the anterior fossa of the skull.

2. Optic neuritis has been noticed in connection with most of the specific fevers, but especially during the secondary stage of syphilis. In the latter case it comes on six to eighteen months after the primary chancre; the retina and often the vitreous become blurred and hazy, but well-defined white patches of exudation are not often seen.

3. Certain morbid conditions of the blood and vascular system may give rise to neuritis and neuro-retinitis; of these

the chief are albuminuria, anæmia, and leucocythæmia, gout, diabetes, lead-poisoning, and the high tension of the arteries which goes with hypertrophy of the heart and sometimes chronic nephritis.

In the neuritis from all these causes there is an especial tendency to hemorrhages into the retina, and when due to kidney-disease (including diabetes) there are generally many whitish patches of exudation and degeneration in the central part of the retina, often grouped in a radiating manner round the macula. In neuritis due to anæmia there may be extreme swelling of the retina and disc, which quite hides the vessels, as well as hemorrhages. Finally, as rare causes of optic neuritis may be mentioned inflammation about the cavernous sinus (usually syphilitic), orbital tumors, periosteal nodes of the skull (invading the meninges), and possibly cerebral hemorrhage, while some cases occur in which no cause can be found.

Treatment.—For optic neuritis due to the causes mentioned in No. 1, it is obvious that not much can be done unless the intra-cranial cause is syphilitic in origin. Hence the treatment almost resolves itself into giving iodides of potassium and sodium, with mercury freely, if there is the least suspicion of syphilis in the case. Thus, for instance, if there is a history of previous syphilitic symptoms, one may order:

Potassii iodidi, ...	gr. v.
Sodii iodidi, ...	gr. v.
Spiritus ammoniæ dil., ...	♏ xv.
Aq. destillatæ, ...	℥ i.

Ter die.

And increase the doses in a few days to gr. x., gr. xv., and so on.

At the same time, mercurial inunction may be used, and the patient kept in a dimly-lighted room, etc.

For optic neuritis in secondary syphilis mercury should be freely given (see treatment of specific iritis), stimulants forbidden, and the patient must shade the eyes or wear protective goggles, of course refraining from any work with them. The prognosis, if the case is seen early and the treatment be thorough, is very good.

The treatment of neuritis due to renal or vascular disease, or the other causes mentioned in No. 3, is a matter which be-

longs to general medicine. It may be mentioned here that the discovery of neuro-retinitis in a case of chronic nephritis is of very serious nature, as affecting the prognosis; most of the cases (at any rate among hospital patients) ending fatally within six to eighteen months after the eye-affection has been noticed. The prognosis of neuritis due to anæmia is, on the other hand, favorable as a rule; if proper dieting and hygienic measures are adopted with the administration of iron (and purgatives if required).

Retinitis Pigmentosa.—In this peculiar disease there is symmetrical progressive failure of sight (especially marked in the dusk, severe cases having "night-blindness") and narrowing of the visual fields; the ophthalmoscopic signs consist in atrophy of the discs with shrinking of the vessels, and the development of a peripheral ring of coal-black pigment patches (in the retina, and often overlaying the vessels). These patches are stellate, or spider-like, with processes which join those of adjoining patches. It comes on in childhood or early adult life (generally the latter), and is often seen in more than one member of the family. Consanguinity of marriage (the parents being first-cousins) appears to be the cause of many cases. Retinitis pigmentosa tends to progress toward complete blindness, and no treatment is known to be of avail.

It may, however, be simulated rather closely by syphilitic choroido-retinitis (whether acquired or inherited); but in these cases there is distinct evidence of old neuritis, and the pigment-patches are less regularly arranged, and may not show the branching processes, which have been compared to those of bone-corpuscles as seen by the microscope.

The Causes of Optic Atrophy.—As already mentioned, any case of optic neuritis may go on to atrophy if the patient live long enough; but primary atrophy of the optic nerve has certain special causes not yet mentioned.

Of these, the chief is disseminated disease of the brain and spinal cord, especially locomotor ataxia (tabes dorsalis). Optic atrophy is also met with in disseminated sclerosis, and is occasionally the only symptom of nerve-disease. Primary atrophy is nearly always symmetrical. Its symptoms have already been mentioned, but it remains to point out the other symptoms of tabes which are usually present when the atrophy comes under notice. One of the most important is the condi-

tion of the pupils. They may be abnormally contracted (myosis), or unequal, and they will generally be found to contract with convergence of the eyes, but not to respond to light. This peculiar and important sign is known as the "Argyll-Robertson symptom," and should always be carefully tested for in any suspected case of tabes. Further, paralysis or paresis of one or more ocular muscles (*e.g.*, the levator palpebræ and one of the recti) is not uncommonly present for a time; the loss of knee-reflexes, the muscular inco-ordination, the darting pains in the limbs, etc., need here only be mentioned.

It is most important to diagnose these cases from what is known as retro-bulbar neuritis (inflammation of the optic nerve behind the globe). With the exception of certain rare cases, the cause of which is obscure, the chief form is that known as tobacco-amaurosis.

In amaurosis, or "amblyopia," from tobacco, a central band of nerve-fibres in the optic nerve is inflamed, and apart from pallor of the disc in advanced cases, the fundus looks quite healthy.

The following are the chief symptoms:

1. Exact or almost exact symmetry of the visual defect—commonly the patient sees only about $\frac{6}{9}$ and 14 J. when he comes under care. (I have, however, recorded one case in which one eye failed some time before the other.)

2. The field for white is normal, but by testing with small pieces of colored paper there is found to be a scotoma (blind area) for green and red, which involves the fixation-point, and extends outward more or less beyond the normal "blind-spot" (corresponding to the optic disc). Sometimes there is also a scotoma for yellow, and still more rarely for blue; and in severe cases the patient hardly distinguishes the color of red and green patches in any part of his field. (In testing the field of vision, it is almost needless to point out that the other eye must be covered up.)

3. The patients are, of course, almost invariably men who have been addicted to smoking strong, dark tobacco (shag, cavendish, or returns) for long periods and in large amounts. Generally they own to using half an ounce of shag daily—though in persons with special susceptibility to tobacco, smaller amounts will produce amaurosis.

4. If smoking be given up, or only mild, light-colored tobacco

used (if the patient cannot relinquish the habit), the vision will, as a rule, steadily improve, and in a large proportion of cases is perfectly recovered. Recovery appears to be hastened by giving nux vomica (tint. nucis vomicæ ℥v., ter die ex aquâ), as well as by the cessation of smoking and chewing tobacco.

The symptoms of tobacco-amaurosis have been described fully, since it is a fairly common disease, and if once diagnosed a very satisfactory one to treat. With regard to the treatment of primary optic atrophy, due to tabes, etc., not much improvement can be hoped for, unless there is a fairly recent history of syphilis. In this case the energetic administration of iodides or mercury should be given a trial, and a few cases will be found to be greatly benefited by it. Nux vomica may also be ordered.

Retinal Detachment and Hemorrhage, etc.—A severe blow on the front of the eye may produce either single or multiple extravasations into the retina, choroid, and vitreous, and if the patient be highly myopic, a slight contusion, or merely the strain of stooping, etc., may cause detachment of the retina. This is recognized by the sudden onset of blindness, which may only affect the upper half of the field, since the detachment is nearly always of the lower part of the retina. On ophthalmoscopic examination with dilated pupil, the retina is seen to come forward into the vitreous, its surface being raised into ridges over which the branches of the central vessels can be distinguished. The appearance of the white furrowed surface is quite characteristic, especially when taken with the history. No treatment is of much avail, though an operation (puncturing the sclerotic far back, so as to let out the fluid beneath the detachment) has been recommended, and is occasionally performed with apparent benefit.

Hemorrhages into the retina and vitreous sometimes occur spontaneously in young subjects, inherited gout and constipation being held to be the chief factors in their causation. Treatment with laxatives, etc., in such cases, is often followed by absorption and recovery of good vision.

A linear streak in retina or choroid is sometimes the result of injury to the eye (rupture due to contre-coup, or stretching of the tunics, and hence generally met with near the centre of the fundus, opposite to the part struck).

The chief tumor met with in connection with the retina is

a glioma, or glio-sarcoma. It develops in childhood, and tends not only to grow forward into the vitreous, but to extend backward along the optic nerve to the brain, or into the orbit. Increase of eye tension, a white mass seen with the opthalscope, blindness of the affected eye, and the early age of the patient, are the chief features. Excision of the globe, with of the optic nerve far back, is the proper treatment, it may prove curative if done early. Glioma may be simuflammatory degeneration of the retina and vitreous glioma"), but the tension is then usually below nor-

CHAPTER IX.

DISEASES OF THE CHOROID.

It is often impossible to draw any line between choroiditis and retinitis, both layers being affected by the inflammatory change; but in some cases the deep pigmentation and sharp outline of atrophic patches, over which the retinal vessels are seen to run, makes it certain that the choroid is chiefly or solely involved.

Choroiditis may be either central (*i.e.*, situated at or near the macula) or peripheral; there may be one or two large patches or multiple small ones (disseminated). Central choroiditis may greatly affect the vision, but peripheral changes may not interfere in the least with sight, and the surgeon frequently discovers them in eyes which the patient states have never "had anything the matter with them."

The chief varieties are the following:

1. Central atrophic choroiditis—in large patches round the disc and about the yellow-spot—associated with high myopia, posterior staphyloma, often vitreous opacities, and sometimes with large pigmentary remains of hemorrhages.

2. Central retino-choroiditis made up of a number of fine dotted changes, pigmentary or atrophic (light-colored), and associated with considerable defect of sight. The disc being normal in these cases, the macular region looks as though it had been dusted over with black pepper, when seen with the direct method. The causes are quite obscure, and the treatment very unsatisfactory; occasionally it appears to be syphilitic, sometimes (in the atrophic form) it is a senile change. In a few cases it is the result of a blow on the eye.

3. In contrast to the very fine changes mentioned in No. 2, larger patches of choroiditis are sometimes seen about the disc and macula, and if not due to myopia (see No. 1), are not infrequently syphilitic.

The more typical and really common form of choroiditis due to syphilis is that which is seen in disseminated patches scattered about the periphery. This disseminated choroiditis may affect one or both eyes (usually both, and is especially noticed in connection with inherited syphilis. The sharply-outlined patches of choroidal atrophy with black borders are very characteristic of syphilis, though not in all cases conclusive evidence.

Finally it may be mentioned that, since most cases with choroiditis come under notice long after the active inflammatory stage is past, treatment is of very little use; if, however, the sight is deteriorating, and there is other evidence of syphilis, iodides of potassium and iron should be given a prolonged trial.

In other cases, such as the myopic form, tonics, rest of the eyes, and the careful avoidance of any work trying to them, with the use of protective tinted glasses, are the measures to be recommended.

Other Diseases of the Choroid.—Tubercle is occasionally met with, usually in children, with general tuberculosis (especially with tubercular meningitis). Scattered roundish pale elevations are seen in various parts of the fundus, each patch being about the size of the optic disc, which may at the same time be inflamed.

In some cases of kerato-iritis (which see, p. 369) patches of exudation or degeneration can be detected in the periphery of the choroid.

The chief tumor of the choroid is a sarcoma, which is often deeply pigmented (melanotic sarcoma). It is usually of the spindle-celled variety, which is twice as common as the round-celled in this situation, the pigmented sarcomata being eight times as frequent as the white ones (Fuchs). The tumor may commence at any age, even in the senile period (contrast with glioma of the retina, which is nearly always met with in children), and pushes the retina in front of it, being noticed as a rounded prominence behind the lens, and tending to fill the whole eye. The tension is raised, and vision more or less affected, according to the extent to which the tumor bulges in front of the central area of the retina. The rate of growth is often rather slow, but after existing some months to a year or two the sarcoma grows through the sclerotic and invades

the orbital tissues. But perhaps before this has taken place secondary deposits have been formed in the liver or other viscera.

Treatment.—As soon as the tumor is positively diagnosed the eye should be excised.

Nerve Supply and Functions.—Of the external muscles of the eye, the [illegible] superior, internal, and inferior recti, and the inferior oblique, are supplied by the third nerve. The external rectus is supplied by the sixth nerve, the superior oblique by the fourth.

The superior rectus alone turns the eye upward and inward, and rotates the globe slightly inward.

The inferior rectus alone turns the eye downward and inward, and rotates the globe slightly outward.

The superior oblique alone turns the eye downward, outward, and rotates the globe slightly inward.

The inferior oblique alone turns the eye upward, inward, and rotates the globe slightly outward.

The internal and external recti simply turn the eye inward and outward.

In associating the movements of the eye it must be remembered that the muscles act in pairs or groups in producing the movements: thus, for instance, in looking straight forward we use the inferior recti and superior obliques; in looking downward and outward with one eye, the external rectus and the superior oblique come into play. It will be noted that the tendency to rotate inward and adduct of the superior rectus is counteracted by that of the inferior oblique, which rotates outward and abduct—the resulting action being a simple elevation.

The [illegible] internal muscles of the eye is fortunately

of the pupil is accomplished through the medium of the sympathetic nerve. Cases occur in which all the external muscles of the eye are paralyzed (ophthalmoplegia externa), others in which the internal ones are paralyzed (ophthalmoplegia interna), or both may be present at the same time. If one-sided the cause is probably about the cavernous sinus, in the wall of which all the oculo-motor nerves are grouped near to each other; if on both sides it is probably due to inflammation and degeneration of the nerve-origins in the floor of the aqueduct of Sylvius. In either case syphilis is frequently the origin of the disease, and more or less complete recovery may follow early and resolute treatment with iodides and mercury. Aneurism of the carotid artery or tumor near the cavernous

Fig. 16.—Diagram of the Nerve-supply to the Eye, etc.

sinus may, however, be the cause of ophthalmoplegia, especially if one-sided; another cause may be meningitis (traumatic or tubercular, etc.).

As a rule paralysis of the oculo-motor system is not complete, but affects one or two muscles or one nerve. Thus, for instance, the sixth nerve may be paralyzed, or the inferior oblique muscle. Squint or strabismus results on attempting to put the paralyzed muscle into action (*e.g.*, in the case of the sixth in making the patient look outward, the head being fixed), and diplopia, or double vision, is usually complained of, except in old cases in which the "false image" is ignored. It is a frequent mistake of students to give as the most common cause of strabismus paralysis of one of the muscles; the convergent squint from over-action of the internal recti in hypermetropia (which see, p. 422) is very much the most frequent.

Divergent strabismus due to weakness of the internal recti (not complete paralysis) is most often seen in myopic patients, or in emmetropic or even long-sighted women who have prolonged strain thrown upon their eyes in needlework, etc. The tendency to it ("latent divergence") is tested for in the following manner: An object is held before the patient's nose at a distance of ten or twelve inches, and he or she is directed to look fixedly at it. A card is then placed before each eye alternately so as to prevent it seeing the object, but not to conceal it from the surgeon's view. When thus covered the eye (if latent divergence be present) will turn slightly outward, and on removing the card the internal rectus will again contract and draw it inward. Such cases are to be treated with tonics, correction of errors of refraction, if present, and sometimes prisms with their bases inward are of use. But the great thing is to avoid prolonged strain of the eyes, and to improve the general health by outdoor exercise, etc.

The term "muscular asthenopia" is applied to these cases of weakness of the internal recti, as well as to irritability of the ciliary muscle; and both may be brought about by any debilitating cause, such as prolonged suckling.

Without going into all the varieties of paralytic strabismus and diplopia, the following points may be noted:

1. The smaller the degree of strabismus the more troublesome is the diplopia. (This is due to the image in the slightly deviating eye being then formed near to the macula, and hence being much more distinct than one formed in a peripheral part of the retina, as in high degrees of strabismus.)

2. When one internal or external rectus is paralyzed, the false image (the one formed on the defective eye) of an object is not deflected, but simply seen at the side of the true image. The separation of the two images (a lighted candle held at twelve feet distance in a dark room is a good object to use in testing) becomes greater the farther the object is moved toward the side on which the paralysis is present.

3. If one of the other muscles (*e.g.*, inferior oblique) is paralyzed when diplopia is present, the false image is inclined or deflected—the reason is obvious on considering the complicated action of the muscle which acts ordinarily in association with the paralyzed one.

4. With diplopia there is frequently giddiness in walking,

etc., which becomes most marked if the patient cover his sound eye.

Finally, it may be added that if the position of the two images corresponds to the eyes (*i.e.*, the patient has double vision, and obliterates the right-hand image on covering his right eye), the diplopia is said to be homonymous. If the reverse is the case, the term "crossed diplopia" is used. Homonymous diplopia is met with in convergent strabismus, crossed diplopia in divergent.

Paralysis of one or more ocular muscles (including the levator palpebræ) may be (1) a symptom of locomotor ataxia, or tabes dorsalis; (2) due to syphilitic disease of the corresponding nerve-trunk, or nucleus; (3) a symptom of meningitis; (4) a result of injury to the orbit (in which case it probably passes off after a time) or to the skull (fractured base), etc.; (5) associated with tumor or hemorrhage at the base of the brain; (6) due to some unknown cause.

If the third nerve alone be paralyzed, the following symptoms are present: The eyelid droops; the globe can be turned outward and downward (to a less extent and with slight rotation inward of the vertical meridian). The power of accommodation is lost, and the pupil is somewhat dilated, and does not contract to stimulation by light of either eye.

If the cervical sympathetic branch to the eye be paralyzed (from pressure of a tumor or aneurism in the neck, rupture of the brachial plexus, etc.), the pupil is perhaps slightly contracted, and it will not dilate on shading the eye. It will be remembered that this nerve comes out from the spinal cord by the upper roots of the brachial plexus, and then joins the cervical sympathetic trunk, to ultimately reach the lenticular ganglion in the orbit by means of the carotid plexus. In paralysis of the cervical sympathetic the palpebral fissure may be slightly narrowed, and the globe a little less prominent than on the other side.

Partial or complete paralysis of the ciliary muscle of both eyes is not infrequently seen after an attack of diphtheritic sore throat. The affection comes on some weeks after apparent recovery from the diphtheria, nearly always in children or young adults, and is associated with (1) loss of knee-jerks; (2) sometimes paralysis of the soft palate, allowing fluids to

regurgitate into the nose; (3) rarely paralysis of the external rectus (Nettleship) or sluggish action of the pupil.

Distant vision is unaltered, but there is more or less defect of near vision, which can be overcome by using a convex lens equal to the amount of lost accommodation. The paralysis is recovered from in a few weeks as a rule, tonics (*e.g.*, syr. ferri phosphatis comp.) and country air hastening the recovery.

CHAPTER XI.

OPERATIONS ON THE EYE.

1. *Excision of the globe* (syn. enucleation).—Anæsthesia is necessary.

Instruments Required.—Spring-stop speculum, forceps, scissors curved on the flat, strabismus-hook.

Position of operator—behind the patient's head.

Introduce the speculum and open it as wide as the orbit will allow; fix it with the screw-stop. Pick up the conjunctiva with the forceps just above the cornea, cut it through, and then continue the division of the conjunctiva all round, keeping as close to the cornea as possible. Having then opened Tenon's capsule, pass the hook under one of the recti muscles and divide it with the scissors; repeat this with each rectus. Keep the hook and scissors close to the globe, and divide whatever is picked up by the former, whether it be a complete muscle-insertion or a part of the fascia. Having thus gone all round the globe, press the speculum back and the globe should project forward. Introduce the scissors on the right side of the eye operated on, with the blades slightly opened, until they meet the optic nerve; divide this while steadying the globe with the fingers of the left hand. The latter now takes hold of the eye, while any remaining tissues are divided. Firm pressure is then applied by means of sponge and bandage. The chief difficulty of the operation lies in the division of the optic nerve.

The glass eye may usually be worn after three or four weeks have elapsed.

Modifications.—With a view to obtaining a good support for the glass eye, and thus enabling it to move well on contraction of the recti, a small glass or celluloid globe may be inserted into the cavity of Tenon's capsule, which is held open by forceps, and subsequently sutured over the globe by very

silk. If this is done, a drain of a few horse-hairs should be laid across in front of the glass globe and under the capsule, to be removed at the end of twenty-four or thirty-six hours; it is perhaps best to sew up the capsule and conjunctiva separately.

Not very infrequently the globe may work out subsequently, but it is generally well tolerated.

Dangers of the Operation.—Provided the tissues are divided close to the globe there is hardly any risk from hemorrhage. If excision is done for acute suppuration (panophthalmitis), there is a certain amount of risk from acute meningitis, and hence if the operation must be done for this condition the orbit should be washed out with some antiseptic solution after the operation.

3. *Tenotomy* may be done under cocaine, but in young children an anæsthetic should be given. The muscle divided is nearly always the internal rectus.

Position of the operator—on the right side of the patient.

Instruments.—Spring-stop speculum, tenotomy-hook, forceps, straight scissors blunt at the end. Introduce and fix the speculum, pick up a small fold of the conjunctiva at the junction of the inner and lower corneal tangent, and divide it with

Fig. 17.—Tenotomy hook.

the scissors. Introduce the forceps within the little wound made, and seize Tenon's capsule and open it in the same manner with the scissors. It is, however, fairly easy to pick up both conjunctiva and fascia at once; the scissors should be pressed toward the caruncle and over the insertion of the rectus to free the latter from the subconjunctival tissue. Now, holding the wound open with the forceps (which have not left go the conjunctiva), introduce the hook, pointing its end directly backward, so as to work under the lower border of the tendon. With a movement of the hook pass it right under the rectus, and raise the latter slightly on it; then introduce the scissors and divide the tendon between the hook and the insertion, close to the latter. If there is any doubt as to complete division of the muscle, introduce the hook again, and divide any

band remaining. Observe the effect upon the position of the eye (a little divergence under the anæsthetic is common, and subsequently passes off).

It may be noted that after complete division of one internal rectus the globe can still be turned inward at the time of operation, owing to the action of the upper and lower recti. Tie the eye up with a light pad and bandage, which may be changed daily, and left off after two or three days. Its use is to conceal the slight ecchymosis which nearly always results; and it is not absolutely necessary to use any bandage at all.

Difficulties of the Operation.—Especially when the patient is not anæsthetized this operation is more difficult than it looks, and to do it well requires considerable practice. The first essential is to make sure that Tenon's capsule is opened before the hook is introduced, otherwise it cannot pass properly under the tendon. The second point where difficulty is met with is in the actual cutting of the tendon, which should be done boldly, and not with very little snips.

There are no special dangers about the operation, but it is worth remembering that just as the tendon is stretched and divided on the hook, the patient's pulse may flag or stop for a few seconds, especially in very young children. The sclerotic has been known to be divided by the scissors or hook (sometimes with a serious result to vision), and hence a hook with a sharp point should never be used.

Tenotomy of the external rectus, partly, perhaps, on account of its insertion being further back than that of the internal rectus, is both more difficult and less satisfactory, but the method of the operation is very similar.

It is not advisable, as a rule, to divide more than one internal rectus at a time, even if the squint is of high degree, for fear of divergence resulting. It is better to wait a few months and see the result of the first operation before performing a second. If, as in most cases of convergent strabismus, spectacles have been ordered, they should be resumed by the patient as soon as possible after the operation.

3. *Advancement* or *re-adjustment* of a rectus consists essentially in exposing the tendon by a vertical incision about 5 mm. from the cornea, and then passing three fine sutures through the conjunctiva and subjacent tissues (short of the sclerotic), and then again through the tendon at some little

distance back, and finally the conjunctiva. The tendon is raised on a hook while the sutures are passed, and it is then cut across, or, if necessary, a small piece excised.

The sutures are then tightened and tied in order from above downward, and the eye bandaged for a few days.

The operation is tedious and rather difficult, and needs to be seen to be understood.

4. *Iridectomy.*—In cases of penetrating wound of the cornea with prolapse of the iris, if it is considered wise to try to save the eye (see "Wounds of the Globe"), a speculum should be introduced, the prolapsing portion seized with iris-forceps and drawn well forward, and then cut off level with the wound. Then with a curette gently press the iris back within the anterior chamber. This operation can only be done satisfactorily within a few days of the injury, and if there is

Fig. 18.—Scissors for Iridectomy.

definite prolapse the sooner it is done the better. Unless there is already iritis (in which case atropine and ice are necessary) it is perhaps best to use eserine freely for a day or two, in order to draw away the iris from the wound; this is especially the case in peripheral wounds. Whether eserine or atropine be employed, one border of the wounded iris will probably remain adherent to the cornea, but (provided the lens has not been originally wounded) perfect vision may be restored and the synechia give no future trouble.

Iridectomy for Optical Purposes.—The cases for which this operation is best adapted are those in which there is a dense central nebula of the cornea, with a clear (or comparatively clear) part downward or to the inner side. It is also sometimes performed for lamellar cataract. It should, if possible, be performed opposite the inner and lower part of the cornea, and the iris should not be excised right up to its ciliary attachment.

Instruments Required.—Speculum, fixation-forceps, narrow keratome, iris-forceps and scissors, small curette or vulcanite spatula. Fixing the globe with the forceps, which grasp the conjunctiva at the upper part, introduce the kera-

Fig. 19.—De Wecker's iris-scissors.

tome just within the corneal margin, and keep the blade parallel with, or a little anterior to, the plane of the iris. Take care not to introduce the point too far; and both enter and withdraw the keratome slowly, widening the wound slightly by a lateral movement on withdrawing. These precautions are to avoid wound of the lens, which is projected forward as the aqueous escapes. The fixation-forceps may be put down, or, if necessary, an assistant takes charge of them. Now introduce the iris-forceps closed, and opening them slightly when the points are opposite the inner part of the iris, seize the latter and draw it gently out; cut off the part outside the wound by one snip of the scissors. The curette is now very

Fig. 20.—Keratome.

gently passed over the wound, and if the iris tends to prolapse, its end is insinuated so as to depress either side; this manipulation is to avoid future bulging or prolapse of the iris. The eye is then bandaged up for three or four days.

Iridectomy for Glaucoma.—This differs from the preceding operation in the following points: 1. A larger wound must be made further backward, 1 to 2 mm. behind the apparent sclero-corneal junction (Nettleship). It will be remembered that the cornea is a little overlapped by the sclerotic, like a watch-glass by the rim of the watch; in fact, as long as the track of the incision is just in front of the iris-attachment it cannot be made too far back. 2. A large piece of the iris must be excised right up to its ciliary origin. 3. The iridectomy should always, if possible, be performed upward, so

that the resulting coloboma may be concealed by the upper lid. 4. Whereas the previous operation may, in adults, be performed under the influence of cocaine, in the case of glaucoma it is better to give an anæsthetic.

Instruments Required. — Speculum, fixation-forceps, Graefe's cataract-knife (not too flexible,) iris-forceps and scissors, curette. The speculum being fixed, and the conjunctival surface irrigated with boracic lotion (this measure is perhaps advisable in all operations in which the globe is wounded), enter the point of the Graefe's knife through the sclerotic, one millimeter behind the corneal margin (of course with the blade of the knife directed upward), pass it directly across in front the iris, transfix, and cut upward, so as to include nearly ıe-third of the sclerotic margin, in which the whole incision

Fig. 21.—Graefe's knife.

lies. The cutting is done by a gradual to-and-fro movement of the knife, the globe being fixed by the fixation-forceps which grasp the conjunctiva firmly below the cornea.

The iris-forceps is now introduced and directed toward the right side of the wound, then opened and made to seize the iris, and draw it out; the scissors then divide the membrane on the right side of the wound. The iris is now drawn steadily out as far as it will come, until a second cut can be made on the left side of the wound. Replace the edges of the cut iris with the curette or small vulcanite spatula, and bandage the eye for a week, changing the dressing once daily, and bathing the lids each time it is changed. Sometimes an iridectomy is performed for relapsing iritis or for occlusion or exclusion of the pupil. In this case it should be free, although the incision need not be quite so large as for glaucoma, and may well be made with the keratome (a broad triangular one). In these cases the iris has generally become either tough or "rotten" by the previous inflammation, and it is very difficult to draw it out; it may be necessary to introduce the iris-forceps more than once.

Dangers and Difficulties of Iridectomy for Glaucoma.— The anterior chamber being nearly always very shallow, and

both iris and lens being pushed forward, there is great difficulty sometimes in making the incision correctly, and if a keratome be used there is no slight risk of wounding the lens-capsule with its point, hence I have described the operation as performed with the cataract-knife, in which there is no such danger. Some operators, however, still prefer the use of a keratome.

The vessels about the sclero-corneal margin being engorged during acute glaucoma, considerable bleeding often occurs when they are cut across. If much extravasation occur into the anterior chamber it may be mostly removed by pressure on the cornea with the curette, but a little blood in this situation is fairly rapidly absorbed.

Sometimes the sudden relief of tension causes free hemorrhage into the retina and vitreous, and the eye will almost inevitably then need to be excised.

Eserine-drops may be used after an iridectomy for glaucoma if the tension still remains full; atropine-drops after an iridectomy for iritis, etc.

5. *Extraction of cataract* (the "modified linear" method).—In a few cases (chiefly those of very slowly maturing cataract, or those in which one eye has been previously operated on and lost in consequence of the operation) an iridectomy is performed upward, and some weeks or months afterward the extraction is completed; that is, the operation is divided into two stages. But in most cases the iridectomy is made as one step of the operation.

Instruments Required. — Speculum, fixation-forceps, Graefe's cataract-knife (which should be ascertained to be extremely sharp along its whole length), fixation and iris forceps, iris-scissors, cystitome (perhaps the best is one with the point bent at right angles), caoutchouc curette. The following instruments should be had in readiness, although not usually required: scoop for extraction of the lens, lid-elevator.

The use of cocaine has practically superseded chloroform or ether in cataract extraction; but in the case of very nervous patients it is better to give an anæsthetic for fear of a sudden squeeze or movement of the eye during the operation. Under cocaine the only really painful part of the operation is the iridectomy, and the patient should be warned of this before the iris is seized and drawn out.

Position—the operator stands behind the patient, who lies down, with the head carefully steadied by the pillow, and who turns both face and eyes somewhat downward.

The speculum is introduced and the conjunctiva irrigated with some non-irritating antiseptic solution (*e.g.*, weak boracic

Fig. 22.—Lid-elevator.

acid lotion). All the instruments should have been dipped in a similar antiseptic.

Note.—Bichloride of mercury solution is not a good one, as it tends to blunt the knife slightly, as well as to produce haziness of the cornea, especially if the latter has been cocainized.

With the fixation-forceps in the left hand, seize the conjunctiva below the cornea exactly in the vertical meridian, fix

Fig. 23.—Cystitome (rectangular).

the globe so that it looks somewhat downward, and make the section at the upper edge of the cornea so as to include about two-fifths of its circumference. The cataract-knife is entered toward the outer side of the eye, at, or a very little behind, the sclero-corneal margin, with its point directed toward the centre of the pupil. As soon as it has entered the anterior chamber the handle is depressed and the blade carried across

Fig. 24.—Curette.

in front of the iris, so as to transfix the cornea at the same level as its point of entrance. By a gentle to-and-fro movement of the knife it is made to cut outward; as it does so, the edge of the blade is sloped a little forward, so that the middle

of the incision is on a slightly anterior plane to that of either end. This is to favor the escape of the lens, which tends to emerge, not directly upward, but forward and upward; *i.e.*, its upper edge is tilted forward by the pressure on the lower part of the cornea. Take care while completing the section

FIG. 25.—Broad fixation-forceps; those usually employed are more narrow at the ends, and have no catch.

not to press on the globe with the fixation-forceps; they should, on the other hand, be simply exercising downward traction. 2. Now lay down the knife, and with the iris-forceps in the left hand, and the scissors in the right, perform a medium-sized iridectomy (the assistant may, if required, continue the fixation of the globe). 3. Introduce the cystitome, held in the right hand, and with the blunt angle of its end first; then turn the instrument so that its point is directed toward the lens, and draw it across the capsule from side to side.

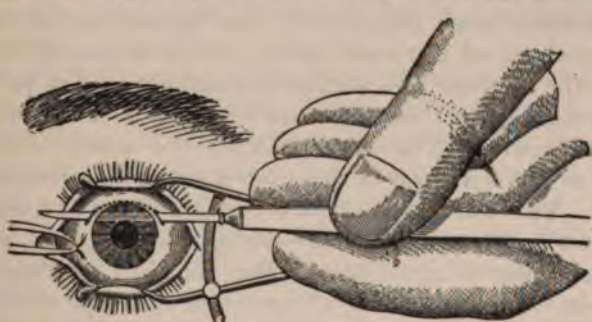

FIG. 26.—Peripheral linear section. The fixation-forceps should grasp the conjunctiva below, and not to the inner side as drawn in this figure.

Some operators add a vertical tear of the capsule; in any case remember the convexity of the lens in using the cystitome. 4. Relax the pressure of the speculum—best done by the assistant drawing it forward so as to keep the lids apart, but not to press on the globe. Apply the curette over the lower part of

the cornea, and exercise steady pressure with it by means of its convex surface. The lens should now present in the wound, and the pressure is kept up until it emerges, carefully relaxing after the widest part of the lens has come through. (At this stage injudicious pressure will be followed by escape of vitreous.) Remove the speculum. 5. Examine the pupil to see if it is uniformly black, or if any part of the lens has remained behind. If the latter, exert backward and upward pressure, with the index-finger placed on the lower lid. If the cataract has been a hard one and complete, this will probably not be required. Otherwise the remains of the lens should be coaxed out if they will come without prolonged manipulation, which is decidedly dangerous; and it is better to leave some lens-matter than to incur the risk of suppuration. 6. Ascertain that the iris does not tend to bulge into the wound; if it does, depress each edge with the curette.

FIG. 27.—Outline of peripheral section.

Finally, place a pad (corrosive sublimate lint, with absorbent cotton-wool, is a good material) over each eye, and bandage both with a single well-adjusted fold, which must exercise slight pressure on the closed lids. A four-tailed bandage, the ends passing above and below the ears, is least likely to slip.

Difficulties and Dangers of the Operation.—If the left eye is operated on, the knife must be held in the left hand in making the section. An immature cataract is very prone not to come out cleanly; on the other hand, an over-ripe one may also give trouble. The wound may be too small to allow of the exit of the lens, and in this case it must be enlarged with scissors. The rent in the capsule may similarly be insufficient (as shown by the lens not presenting on pressure), and the cystitome must be again used. But the chief accident which it to be dreaded at the time of operation is escape of vitreous. If the section is made too far back, or if the vitreous be too fluid, this may occur during the moment the pressure is applied, or it may follow the escape of the lens (generally due to the pressure being continued too long).

If vitreous present before the lens, the scoop must at once be introduced, passed behind the cataract, and the latter gently drawn out by means of the projecting lower edge of the instrument. The bead of vitreous may then be snipped off with scissors, and the eye bandaged as soon as possible.

The chief remaining complications are the following:

1. Vomiting or coughing, etc., during the next few hours, producing hemorrhage into the eye, or escape of its contents. Hence the importance, where an anæsthetic is used, of carefully preparing the patient, and the great advantage of using cocaine.

2. Iritis coming on during the first three or four days; it is to be suspected if the patient complains much of pain in the forehead and eye, and is to be treated by atropine and leeches to the temple.

3. Suppuration starting in the wound and spreading to the whole globe. Pain, restlessness, chemosis of the conjunctiva, and a yellowish tinge about the wound and pupil are the chief signs. As a rule, it leads to disorganization of the globe, and then requires excision; but if recognized at first, the opening of the wound and irrigation through a fine nozzle with an antiseptic solution, or the application of the galvanocautery to the wound (in the very earliest stage) has been occasionally followed by arrest of the process.

Severe iritis and suppuration are the chief causes of complete loss of vision after cataract extraction.

4. There is a very small risk of sympathetic ophthalmia, since the wound practically lies in "the dangerous area."

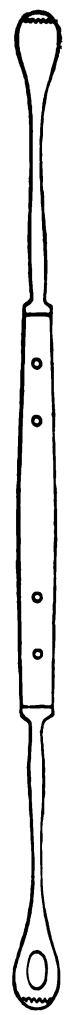

FIG. 28.—Scoop for extraction of lens.

Modifications of the Operation.—Some operators dispense with the iridectomy; others make a wholly corneal section. The capsule may be cut with the Graefe's knife, and the use of the cystitome avoided, or the lens may be got out in its capsule entire by means of the scoop. There is some variety in the kind of knife used, and the old corneal flap operation was done with a Beer's triangular knife.

After-treatment of Cataract Cases.—The bandage and pad is changed at the end of twenty-four or forty-eight hours, the lids gently bathed with warm water, and the dressing again changed daily until six or seven days have elapsed, when a shade may be worn and the patient allowed up. Previous to this, it is best to keep the patient in a darkened room. At the end of a fortnight the patient may go out, wearing protective goggles, and as soon

as the wound is soundly healed, and the eye quite quiet, the vision should be tested and glasses ordered. Two pairs of spectacles will be needed, one of from + 10 D to + 13 D for distant vision, the other + 15 D to + 20 D for reading. Astigmatism may interfere with these giving the patient good sight, and should be then corrected. Another frequent cause of defect after the operation is the persistence of opaque lens capsule; this is detected by oblique illumination (the pupil being dilated), and requires one or more needling operations.

The after-treatment just mentioned is only a rough outline, and must be modified to suit different cases. Surgeons are now becoming less rigorous in the restrictions as to darkness, etc., and some only cover up the eye operated upon. (For operation on soft cataracts, see p. 377.)

CHAPTER XII.

ON REFRACTION.

In what follows a purely practical review of the methods of testing for spectacles will be given, an elementary knowledge of optics being assumed. For fuller details the student may refer to the works of Landolt, Nettleship, and Morton. So complicated are some of the problems in connection with working out some errors of refraction that only long practical experience can enable one to avoid errors, and it is impossible in the space at our command to give more than an outline of the subject.

An emmetropic eye is one in which parallel rays are brought to a focus on the retina when the eye is at rest, *i.e.*, when no accommodation is being used. Hence a patient whose accommodation is paralyzed by homatropine, and who can then read $\frac{2}{20}$, may be considered emmetropic, since rays coming from a point at a distance of 20 feet, or 6 metres, may be practically considered to be parallel.

A myopic eye is one in which parallel rays come to a focus in front of the retina when the eye is at rest. Hence myopia is invariably accompanied by more or less defect of distant vision. Myopia usually comes on in childhood, or early adult life, when the eyes begin to be much used in near vision, reading and the like, and often tends steadily to advance. Strain of the eyes, as in reading bad or very small print, or in working in a bad light, favors its development and progress, though occasionally high degrees of short-sight are met with in patients who have never used the eyes much in near vision.

A short-sighted patient will be found usually to hold a book abnormally close to the eyes, as well as to have defect in distant vision.

In hypermetropia parallel rays, when the eye is at rest, are brought to a focus behind the retina. The defect depends

upon the shape of the eye or curvature of the cornea, and is often inherited, a large proportion of eyes being hypermetropic at birth. It usually remains quite stationary, but sometimes decreases, so that a hypermetropia of one or two dioptres may, in the course of a few years, disappear; this, however, is unusual. By accommodation (contraction of the ciliary muscle), rays from a distance passing into a hypermetropic eye can be made to converge on the retina; hence a young subject with powerful ciliary muscle can readily conceal a considerable degree of hypermetropia.

By presbyopia, or old-sight, is meant that stage of the gradual failure of accommodative power at which, in an emmetropic eye, reading small print becomes impracticable at a

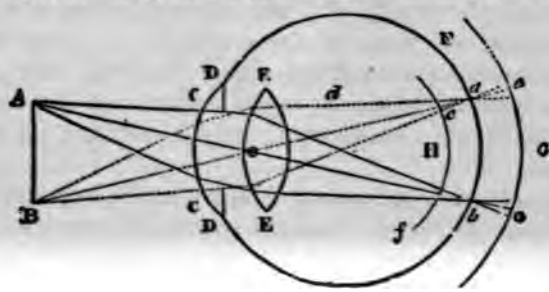

FIG. 29.—H, hypermetropia; E, emmetropia; G, myopia. This diagram represents the condition of an eye when looking at a distant object A B, the ciliary muscle being at rest. A clear image is then only formed in the emmetropic eye E, but by using the accommodation it can also be obtained in the hypermetropic eye H.

nearer distance than nine inches. The power of accommodation is at its maximum (14 D) about the age of ten years, and steadily decreases, until at the age of seventy-five no accommodation is possible. This gradual decrease depends both on failure of the muscle and loss of elasticity of the lens, especially the latter. At forty to forty-five years a normal eye possesses 4 or 4.5 dioptres (for explanation of "dioptre" see p. 433) of accommodation, and can read 1 Jäger print as near as ten inches. At or after this age it will require a convex lens to bring the print at this distance into focus. The practical deduction is that presbyopia usually begins at forty-five years, and steadily increases. Thus an emmetropic eye at forty-five will probably need + 1 D for near vision, + 2 D at fifty, and so on, with an increase of + 1 D for each five years up to fifty-five or sixty, after which the increase is rather slower.

A hypermetropic, or long-sighted patient, will need glasses for reading sooner than an emmetropic eye; thus a patient with + 1 D of H will probably want this glass at forty years. In myopia, on the other hand, the near-point is to start with abnormally near the eye, and hence the onset of presbyopia is delayed. In high degrees of short-sight the patient may be able to dispense with glasses for reading until a very advanced age.

Astigmatism.—Not only may the cornea be abnormally curved in its whole extent, but it may be unequally curved in two meridia, the axes of which are at right angles to each other in "regular astigmatism," the usual form, and the only one which can be corrected by glasses. The horizontal meridian of the cornea is usually that which is least curved, the vertical one the most. In "simple myopic astigmatism," one meridian, usually the vertical one, is myopic, the other emmetropic. Various other terms are used with regard to astigmatism; thus in "compound hypermetropic astigmatism" both meridia are hypermetropic; but one of them, usually the vertical one, is more so than the other. The meridia are, however, frequently not exactly horizontal and vertical, but inclined, still always at right angles to each other in regular astigmatism.

In testing for errors of refraction, always test each eye separately; note both near and distant vision, and begin with the latter. The younger the patient the more important is it to remember that contraction of the ciliary muscle may give deceptive results, and to avoid this by the use of atropine or homatropine.

1. In hypermetropic cases the patient very commonly complains of aching in the eyes or forehead in reading or writing, due to the strain upon his ciliary muscle. The higher the degree of long-sight the earlier will the patient probably complain; thus he may not feel any inconvenience from H of + 1 or + 2 D until he is forty years of age; but cases differ very much in this respect, women appearing to be more inconvenienced by low degrees of hypermetropia than men, and constant application of the eyes to fine work, reading, or writing, causing a slight amount of hypermetropia to be early noticed. A frequent complication of hypermetropia in early life is convergent strabismus (the most usual form of squint); in this, while one eye is directed on an object the axis of the

other is directed to its inner side. The squinting eye is frequently amblyopic; that is, while it retains some vision (*e.g.*, $\frac{20}{100}$ and 12 J.), it cannot be improved much above this by any glass. No change can be found in the fundus, and the amblyopia is probably congenital. In these cases the strabismus is constant; it is always the defective eye which squints. In others the strabismus is alternating; that is, sometimes one eye squints, sometimes the other, and then both eyes, as a rule, possess good vision. The degree of squint is by no means proportional to the amount of hypermetropia; as a rule the cases with high H (+ 8 D to + 12 D) do not squint. Sometimes, but only occasionally, convergent strabismus is found in emmetropic eyes.

Example 1.—A child is brought with convergent strabismus. The distant vision is found to be $\frac{20}{200}$, or $\frac{6}{6}$ in one eye, $\frac{20}{100}$ or $\frac{6}{36}$ in the other (the squinting one). Paralyze the ciliary muscle, by the use of atropine for two or three days, or by the application of homatropine (4 grains to the ounce) thoroughly to both eyes for about an hour. The refraction is then tested either with keratoscopy or the ophthalmoscope, the first being the most convenient. Without going into the theory of keratoscopy, or, as it is sometimes called, retinoscopy, the following outline may suffice: The patient sits in a dark room with a good light above and behind his head, and is told to look straight forward. The observer seats himself at a distance of one metre in front of the patient, and with a slightly concave perforated mirror before his eye reflects the light on to the patient's cornea. He then tilts the mirror slightly from side to side, and from above downward. A shadow is seen to move across the patient's eye in the same direction as the mirror if the eye is myopic, in the opposite direction if emmetropic or hypermetropic. Supposing the latter, convex lenses are in turn placed just in front of the patient's eye, and the movements of the mirror repeated until no shadow is observed, when the error of refraction is slightly over-corrected. For example, if neutralization occurs at + 4 D, when the shadow no longer moves across the eye, or has become extremely faint, the amount of hypermetropia will be about + 3 D. The rule is, from the result found by keratoscopy in hypermetropia deduct from + 5 D to + 1 D; add to it in myopia −.5 or − 1 D (in high myopia keratoscopy is not so trustworthy as in other cases).

In our example of strabismus the hypermetropia has been found to be + 3 D, and no astigmatism exists, since the spherical lens of + 4 D corrects the shadow in both meridia. The result may now be confirmed by the ophthalmoscope, the observer using the direct method, relaxing his accommodation to the utmost, and rotating the convex glasses in his instrument so long as the details of the disc are clearly defined. The highest lens with which this is possible indicates the amount of hypermetropia. Or if the patient can read, confirm the result by using convex lenses with the type at six metres distance, and it will be found that with the + 3 D he reads $\frac{6}{6}$ with the best eye, the vision of the squinting one being not materially improved.

The full, or very nearly the full, correcting-glass should now be ordered for constant use, and if the squint be of only moderate extent, after some little time the eyes are found to remain straight so long as the glasses are worn. After a few years' use of the glasses the strabismus will very likely be permanently cured. If, however, the squint is very marked (over 20°), tenotomy of one internal rectus will probably be required; and if this does not succeed, tenotomy of the opposite internal rectus or advancement of the external muscle may be necessary. But in any case of hypermetropia with convergent squint, a thorough trial of fully-correcting glasses should be made, so long as the patient is old enough to wear them. In children under two or three years, if it is not practicable to use them, the internal rectus of the squinting eye may be divided first, and subsequently the error of refraction corrected.

Example 2.—A young adult comes complaining of headache on use of the eyes in near vision, and of the letters "running into one" when he reads. There is no strabismus. Take the near and distant vision of each eye, noting the far and near point for reading, and then examine for "manifest hypermetropia." This is done by putting up a high convex lenss (say + 6 D) before the eye, and then gradually diminishing its effect by placing successive concave glasses (− 1 D, − 1.5 D, − 2 D, etc.) in front of it. The highest lens with which he reads $\frac{6}{6}$, indicates the manifest hypermetropia, and in patients over thirty this is often the total amount, and this glass should be ordered for reading, etc. But in our example, a

young adult, the probability is that he is concealing a certain amount of hypermetropia by contraction of the ciliary muscle. This, the "latent hypermetropia," should be estimated by keratoscopy or the ophthalmoscope, after paralyzing the accommodation with homatropine. The great advantage of this drug over atropine is that its effects pass off in a day, whereas atropine leaves the accommodation impaired, as a rule, for a week. And for practical purposes the four-grain solution of homatropine, if applied several times during an hour, will obtain perfect relaxation of the ciliary muscle.

Let us suppose that a total hypermetropia of + 7 D is found in one eye, of + 5 D in the other ("anisometropia," or unequal refraction in the two eyes). The patient with this degree should certainly be ordered to wear glasses for near vision, but will prefer to have not quite the full correction. Deduct + 1 D, or + 1.5 D, from the result, and order + 5.5 D for one eye, + 3.5 D for the other. More commonly the two eyes are equally long-sighted, and when in low degrees (*e.g.*, + 2 D or + 2.5 D) order the full correction, in high degrees deduct one or two dioptres. But in doing this consideration must be made for each individual case; some patients will use the full correcting glass without difficulty, for others it is best to order a weaker lens at first, and subsequently (after some months' use) increase the strength.

Keratoscopy is the best method of detecting hypermetropia, and it is very easily learnt; the direct method with the ophthalmoscope is more difficult, but equally good in the hands of practised observers (provided both patient and surgeon are relaxing their accommodation at the time of the observation). In examining by keratoscopy a case of either high hypermetropia or myopia the shadow will be noticed to move slowly, to be rather ill-defined, and to have a somewhat crescentic border. As the successive correcting lenses are placed before the patient's eye in the frame, and the movements of the mirror repeated, the shadow moves faster, becomes more sharply defined, and loses its curved outline.

If a hypermetropic eye be examined by the indirect method, and both lens and observer's head and mirror moved steadily away from the patient, the size of the disc's image is seen to decrease; in myopia if this experiment is tried the opposite is the case. If the surgeon use his ophthalmoscope mirror alone

and reflect the light into the patient's eye, the retinal vessels and disc are distinguished (*e.g.*, at a distance of one or two feet); and if he then move head and mirror from side to side, the image of the vessels will be noticed to move in the same direction as his head. In myopia it moves in the reverse direction.

To recapitulate:

(1) In hypermetropia convergent strabismus is a frequent symptom in childhood; in later life frontal headache and difficulty in near vision (and in some cases of high degree in distant vision also) are the most characteristic features. It may be noted that some congestion of the lid-margins and even blepharitis are occasional complications of long-sight, and may be cured by wearing the proper glasses.

(2) The total amount of hypermetropia is divided into the latent and manifest parts; the latter can be estimated by the highest lens the patient takes for clear distant vision, the former only after the ciliary muscle has been paralyzed for a time (in young subjects).

(3) Keratoscopy and the direct ophthalmoscopic method are the best ways of determining the degree of long-sight; but in every case, if the patient can read, the result should be confirmed by trial in distant vision of the lenses before ordering the spectacles.

A common mistake of students is to imagine that because the patient does not see well in near vision the first thing in hypermetropia is to try what glasses he can read small print well with; this would often give the right result, but in many cases would be quite untrustworthy.

2. *Myopia.*—As already stated, defect in distant vision is the commonest symptom, and if the short-sight be more than of very moderate degree, it will be found that the patient holds print nearer than normal to the eye. Myopia is due to elongation of the globe, which may often be detected by the prominence of the eye or the great extent of sclerotic exposed on looking sideways. In high degrees there is nearly always bulging of the sclerotic at the posterior pole—*i.e.*, just outside and around the optic disc. This bulging is accompanied by an atrophy of the choroid over it, and thus with the ophthalmoscope a whitish crescent or circle is seen; if the former only, the crescent is observed to the outer side of the disc.

The term "posterior staphyloma" is applied to the bulging. The choroid is generally thinned, and its vessels more obvious than usual, and in some cases patches of choroidal atrophy are present in the yellow-spot region. Myopia tends to increase, partly by the strain of the recti muscles upon the globe; but the increase, as a rule, does not occur after about twenty-five years; any severe illness, and especially congestion of the eyes brought about by excessive strain in near vision, and stooping over the book, etc., favor its progress. In high myopia there is a tendency to several complications, all seriously damaging the sight. These are (1) opacities in the vitreous ("muscæ volitantes," or floating spots of irregular shape, form a common symptom, even though no opacities can be detected by the surgeon); (2) hemorrhage into the vitreous or retina after slight blows, or coming on spontaneously; (3) detachment of the retina; (4) choroidal atrophy, or "central choroiditis;" (5) abnormal fluidity of the vitreous and (6) secondary cataract, especially of the posterior surface or pole of the lens.

Just as convergent strabismus is a frequent complication of hypermetropia, so divergent squint is sometimes met with in myopia, but much less frequently. It is due to weakness of the internal recti, following upon the strain thrown upon them in near vision; its treatment consists in (1) removing the cause by using proper glasses; (2) the addition to these of prisms with their bases directed inward; (3) division of the external rectus; (4) advancement of the internal rectus of the diverging eye. Tenotomy of the external rectus alone rarely gives satisfactory results.

The rate of increase of myopia varies much among its subjects; sometimes a low degree (*e.g.*, −3 D) coming on about puberty persists without becoming more throughout life. In these cases we rarely find a marked crescent round the disc, and beyond the defect in distant vision, such an amount of short-sight entails no disadvantage. Indeed, as soon as the presbyopic age (forty-five) is reached, it is an actual advantage, since glasses may not be required for near vision until about fifty-five or sixty years. In the more common cases in which the myopia increases, the eyes are frequently weak and irritable; such complications as blepharitis or chronic conjunctivitis are not infrequent. The muscular weakness (or "as-

thenopia") has already been alluded to, as well as the graver complications.

To give one or two examples of myopia and myopic astigmatism:

Example 1.—A young man complains that he cannot see across the street so well as he used, and that he is frequently troubled with floating specks before his eyes, particularly when he is in a bright light. His distant vision is taken first; he reads $\frac{6}{36}$, or $\frac{20}{100}$, with either eye, making out the letters with some difficulty, and "screwing up his lids in order to get a clearer view. His near vision is then tested, and he is found to read 2 J. from 3″ ("punctum proximum," or p. p.) up to 12″ (p. r. = punctum remotum); beyond this distance he cannot read it. The rule in myopia now comes in—divide the distance of the far point in inches into 40, and the result indicates roughly in dioptres the amount of myopia present; exactly the same is true if the distance of the far point be taken in centimetres and divided into 100.

In our case 12 divided into 40, or 30 divided into 100, gives 3.3 D. A — 3.5 D glass is now placed before each eye, and the distant vision is found to be about $\frac{6}{9}$, or $\frac{20}{30}$, and no spherical glass is found to improve. Slight astigmatism is suspected, and the patient examined by keratoscopy, when it is found that a — 3 D corrects the shadow-movement in the horizontal meridian, a — 4 D lens that in the vertical. On adding a — 1 D cylinder to — 3 D spherical he is found to read $\frac{6}{6}$ and 1 J. up to about 20″. These glasses are ordered thus:

$$\frac{-\ 3\text{ D spherical,}}{-\ 1\text{ D cylinder axis horizontal,}}$$

and may be used both in near and distant vision.

NOTE.—It must be remembered that a concave lens lessens the size of an image, and hence when a high one is ordered the patient finds that print, etc., is rendered so small that it is impossible to use the glasses for near vision. And so long as a myopic patient can read moderate-sized print at a reasonable distance (10″ to 12″) it is unnecessary to wear the glasses, except for obtaining a clear view in the distance. It is generally found that up to — 4 D or — 5 D can be comfortably worn in near vision (and if this is the total myopia they may be ordered for constant use). Above this degree the full

correction, or nearly the full, may be ordered for use in distance vision, and that glass (usually — 4 D or — 5 D) which will enable the subject to avoid bringing the book nearer than 10″ for use in near vision. To avoid the trouble of changing the spectacles sometimes a moderate concave lens is ordered in spectacles for constant use, and another concave lens in eye-glasses for putting up in front of the spectacles when clear distant vision is required.

In our example the eyes are examined with the ophthalmoscope, and no cause found for the "muscæ volitantes," the fundus being normal apart from the myopia, and no floating particles to be seen in the vitreous (to test for these use the direct method, keeping one's head some six inches away from the patient's, while having rather a weak light, and making the patient look up and down and from side to side). If this symptom be very troublesome, and if the patient's eyes are irritable in ordinary sunlight, it is a good plan to order the proper glasses in light cobalt or neutral tint. In any case of myopia the patient should be warned against reading in a bad light (*e.g.*, in some railway carriages at night), against stooping over his work, and against persisting in the latter after the eyes begin to ache; and if out of health tonics, etc., should be ordered. The quality of the print is considered to be an important factor, and may account partly for the great prevalence of short-sight in Germany. The best position for the artificial light in reading, etc., is on the left side, and so placed or shaded that it is thrown on to the book or work, and not into the patient's eyes.

Example 2.—A middle-aged patient has worn concave glasses for long, and now complains that they do not help much, and that the eyes and head ache on any attempt to use the former. It is found that V = $\frac{1}{60}$, and that only 4 J. can be read up to 4″. Some homatropine is applied and dotted opacities in lens and vitreous discovered, there being a large posterior staphyloma and irregular choroidal patches of atrophy about the yellow-spot region. A — 10 D or — 12 D lens raises the vision to $\frac{6}{36}$, beyond which it cannot be improved.

It is very difficult to order glasses which will help much in such a case; probably with a — 6 D or — 8 D (by empirical rule deduct — 4 D from the total in these cases) the patient will be best able to do his work, and these may be ordered.

But he should be warned against anything likely to produce congestion of the eyes, and tinted glasses, or even, in bad cases, protective "goggles," may be of service.

The following points in myopia may be noted: 1. Distant vision is defective, and improved by concave lenses. 2. In near vision the far-point is nearer the eye than normal. 3. By keratoscopy the shadow is found to move in the came direction as the mirror if over − 1 D. 4. By the mirror alone the retinal vessels are seen distinctly at some distance from the eye, and their image moves in the opposite direction to the mirror. 5. By the indirect method the disc looks smaller than normal, and appears to increase in size as both mirror and lens are withdrawn. 6. The disc cannot be clearly seen (unless the observer is himself myopic) by the direct method without a concave lens in the ophthalmoscope.

It has already been said that in testing young adults or children, to avoid errors, the patient's accommodation must be relaxed, and generally homatropine or atropine is necessary for this purpose. Most people will see more clearly in the distance with a low concave lens in front of their eye, and many more clearly in near vision with a convex glass; but neither necessarily implies any error of refraction. Hence the rule—take the distant vision first, and exclude the presence of hypermetropia by using convex lenses, and suspect spasm of accommodation when the patient's answers vary from time to time.

The question of testing for astigmatism has already been alluded to, and need not here be much further discussed—except to say that where it is suspected owing to the failure of spherical glasses to bring the vision up to or near perfection, and the absence of any cause for defect on examination by direct illumination (a frequent cause for this defect is an old nebula of the cornea) or by the ophthalmoscope, the ciliary muscle should be paralyzed by homatropine, and keratoscopy employed. If astigmatism be found by this method, the result should be confirmed by testing the patient's distant vision, and unless the cylinder in the usual cases of compound astigmatism is a definite improvement, it should not, as a rule, be ordered. In cases of mixed astigmatism (where one meridian is myopic and the other hypermetropic), if the defect is of low degree, the hypermetropic meridian, as a rule, alone requires correction.

Some puzzling cases are met with in which an error of refraction is suspected from the visual defect and other symptoms, and yet it cannot be found. Nebulæ of the cornea from previous ulceration, and a more or less conical condition of the cornea, account for many of these cases, and if the eye is examined by keratoscopy and by direct illumination, neither should be overlooked.

Presbyopia.—An emmetropic patient will, as already stated, want glasses for reading at, or soon after, forty-five, and starting form + 1 D he will require an addition of about + 1 D every succeeding five years—although this rule is only roughly true after fifty-five. Unusually rapid increase of presbyopia sometimes is an early sign of glaucoma; unusually early onset probably implies existing hypermetropia, late onset the presence of myopia. It may be noted that sometimes myopic patients complain of difficulty in near vision at the presbyopic period, and a low concave lens is found to help them—though these cases are infrequent.

In testing a presbyopic patient take the distant vision of each eye first, and see if there is any hypermetropia; if this is found, add the amount to the glass required according to the rule given, and order the total amount for near vision, first confirming the result with 1 J. or 2 J. type. If there was originally myopia, its amount in dioptres would have to be deducted from the convex glass in ordering.

Example.—A man aged fifty reads $\frac{6}{12}$ with either eye, and + 1 D brings the vision up to $\frac{6}{6}$, + 1.5 D not giving so good a result; without glasses he reads 6 J. up to 12″ (p. r.) with difficulty. His presbyopia should be + 2 D, to this + 1 D (manifest hypermetropia) is added, and it is found that with + 3 D he reads 1 J. from 8″ to 16″; these are ordered. If + 2 D or + 4 D of hypermetropia had been found, it might be worth while to order two pairs, one of this strength for ordinary use in distant vision, another with the presbyopic correction added for use in reading, etc. In such a case the upper half of the spectacle lens may be cut to correct the hypermetropia correction, the lower to the total amount. This form was invented by Franklin, and is called after him; it is unsuited for poor patients on account of the expense.

It should be noted that the presbyopic table is calculated for ordering spectacles to bring the patient's near-point in

reading up to 9″ from the eye. The range of his vision will depend on his age and the amount of accommodative power still possessed.

A fair number of presbyopic patients do not require the glasses for reading or writing so near as 8″–12″, but, as in the case of carpenters, musicians, etc., wish to see clearly at a distance of some 18″–24″, or even rather further. In these cases the spectacles should be weaker than the table would indicate, and the patient's own choice should be the chief guide.

To recapitulate: 1. In hypermetropia without strabismus in young subjects the full correction may be ordered for near vision, unless it is of high or moderately high degree (+ 5 D to + 12 D); in the latter case a certain amount must be deducted, varying with the patient's accommodative power. It is not necessary to use the glasses for distant vision.

2. In hypermetropia with strabismus convergens, order the full correction (deducting about + 1 D from the result given by keratoscopy). The glasses are to be worn constantly.

3. In myopia the glass that gives the best result in distant vision may be ordered, but not for constant use, unless it is — 4 D, or under that amount. If higher than that, deduct — 2 D to — 4 D in ordering for near vision, and no glasses need be worn for this unless the patient is in the habit of bringing the head nearer to the print than 9″ or 10″ without them. Always aim at under-correcting myopia rather than over-correcting it.

4. In presbyopia order according to the presbyopic table, making allowance for the patient's special requirements as to working-distance, and add or deduct according as he is hypermetropic or myopic.

5. Astigmatism is nearly always complained of before the presbyopic age, and the best correcting-glass is ordered for near and distant vision, except in high compound myopic astigmatism.

CHAPTER XIII.

DEFINITIONS AND EXPLANATORY NOTES.

Blepharo-spasm—spasmodic closure of the lids from contraction of the orbicularis palpebrarum—is met with in some cases of ulcer of the cornea, foreign body either on the cornea or conjunctiva, and in a milder degree in albinoes, or in myopia or myopic astigmatism.

Buphthalmos (ox-eye) is a peculiar disease, most allied, perhaps, to glaucoma, which comes on in very early life, affects both eyes, and causes very great defect of sight. The eye is enlarged in all its diameters, the anterior chamber very deep, the cornea generally hazy, the tension slightly increased. Iridectomy is of little or no avail, but eserine is worth a trial.

Chemosis.— Inflammatory swelling of the conjunctiva, which tends to protrude between the lids and to overlap the cornea. It may consist chiefly of œdema, or may be much firmer and more solid, in which case there is risk of the cornea perishing from obstruction to its nutrition through obstruction of the blood-vessels. Mild examples are seen in ectropion or complete facial paralysis, sometimes; severe ones in gonorrhœal ophthalmia. Its treatment should be directed to the cause, but if very severe the chemosed parts may be incised with scissors in several parts.

Cocaine.—To procure anæsthesia of the cornea and conjunctiva, drop in a freshly prepared solution of the pure salt (2 per cent in boracic solution or distilled water) two or three times, at intervals of three or four minutes. Slight smarting is felt at first, the amount varying apparently with different individuals. This method is suitable before cataract extraction, iridectomy, etc. Cocaine does not render the iris insensitive, but produces some dilatation of the pupil and loss of accommodation, with slight widening of the palpebral fissure, and contraction of the superficial blood-vessels, due to its

stimulating the sympathetic (Jessop). One great use of cocaine is in the removal of foreign bodies from the cornea.

Coloboma of Iris.—An aperture or deficiency in one part of the iris, which may be the result of an iridectomy, or may be congenital. If the latter, it is usually, but not always, symmetrical, and is situated at the lower part of the iris (this being the last part of the iritic circle to close in its development). It may only involve the pupillary margin, and always becomes narrower toward the ciliary margin. Sometimes there is a corresponding coloboma of the choroid, seen by the ophthalmoscope as a white patch of exposed sclerotic; but this is much rarer than the cases of congenital cleft in the iris.

Dioptre.—Dioptric System.—The unit of measurement in this system is a lens with focal length of 1 metre = 40 inches. Two dioptres = a lens of 20″ focal length; three dioptres = 13″; four dioptres = 10″, and so on. To convert a measurement in dioptres to one in inches simply divide the numeral given into 40. A dioptre is expressed by the capital D with the + or − sign before it, according as the lens is convex or concave. To be consistent with the dioptric system, the distant vision should be reckoned in metres; thus $\frac{6}{36}$ implies that the patient only reads at six metres' distance the letters a normal eye would read at thirty-six metres, and so on. Six metres is just about twenty feet, and $\frac{20}{100}$ is very nearly the same as $\frac{6}{36}$ in stating the vision. The old feet-measurements, from $\frac{20}{20}$ (perfect vision) up to $\frac{20}{200}$, are still much used, and there is little difficulty in converting terms of the one system to those of the other.

Epicanthus.—A congenital redundancy of skin over the upper part of the nose, which projects on either side in a fold which more or less conceals the inner angles of the palpebral fissure. If very pronounced a medial piece of the skin may be excised, and the wound sutured, but as a rule no treatment is required.

Field of Vision.—The farther away from the macula that an image is formed on the retina, the less distinct does it become to the patient; and thus, when looking fixedly forward with one eye (the other being covered) an object moving horizontally or vertically is only distinguished up to a certain distance from the fixation-point. To register accurately the field, a perimeter must be used, small squares of white and

colored paper being employed in it. The normal field for white (squares about one centimetre in size being used) is oval in shape, and extends about 65° upward, inward, and downward, about 100° outward from the fixation-point. The fields for blue, yellow, red, and green are progressively smaller in the order named. It may be noted that the two smallest fields, red and green, are the ones which show most defect in tobacco amaurosis, and several other retinal and optic-nerve diseases.

Without a perimeter, the field may be roughly estimated by making the patient stand with his back to the light, cover one eye, and fix the surgeon's nose with his other one, while a mounted square of paper is moved away from the fixation-point in all directions, the patient giving the word when it goes out of sight. In this experiment the surgeon faces the patient at a distance of about eighteen inches, and makes the patient continue to look at the fixation-point.

Narrowing of the field is observed in cases of glaucoma, retinitis pigmentosa, atrophy of the optic nerve, and some other forms of retinal and choroidal disease.

Hypopyon.—The presence of pus, or puro-lymph, in the anterior chamber. A yellowish-white crescent at the lower part of the chamber is seen; it may be the result of iritis (rarely), or of ulceration of the cornea (especially the serpiginous form), or of penetrating wound. (See Fig. 2.)

Treatment.—Hot boracic or belladonna fomentations. If these fail, let out the pus by means of a needle introduced just in front of the sclero-corneal margin.

Nebula of the Cornea.—The white opacity of the cornea left by previous ulceration, or by interstitial keratitis. Like other scars, it is very slow to disappear, and often a very faint nebula accounts for considerable defect of vision, especially in the distance. A stimulating ointment (yellow oxide of mercury, four to eight grains in the ounce) seems to hasten the absorption of recent opacities, though little or no improvement can be looked for in the case of old ones.

If an old nebula or leucoma is very conspicuous, the operation of tattooing is sometimes performed. A needle, charged with liquid Indian ink, is thrust into the leucoma at a number of points, and thus the scar rendered black and less easily detected.

Proptosis.—Protrusion of the entire globe. It is one of the symptoms of exophthalmic goitre, and is also met with in cases of "pulsating orbital tumor," or orbital sarcoma.

Ptosis.—Drooping of the upper lid. May be congenital, or may be due to paralysis of the levator palpebræ. Is a frequent symptom of locomotor ataxia, in which case one or other of the oculo-motor muscles is often paralyzed at the same time. This form is nearly always temporary, the paralysis clearing off or much improving—especially under treatment with iodide of potassium. In old people ptosis sometimes comes on with marked laxity of the lid; it is, as a rule, of only slight degree. In these cases, and for congenital ptosis, an operation (excision of an oval fold of skin from the upper lid) may be required.

Pterygium or Pterygion.—A small triangular growth of conjunctiva invading the surface of the cornea, and generally following slight ulceration. It is a rare condition, and may be treated by dissecting off the corneal part, and then turning in and fixing with a suture its apex.

Staphyloma.—A bulging of some part of the cornea, or sclerotic. If of the latter at the posterior pole of the eye (around and to the outer side of the optic disc), it is called posterior staphyloma, and is met with in high myopia. It is recognized with the ophthalmoscope by the whitish crescent seen at the margin of the disc. If of the cornea, or at the ciliary region, it is called anterior staphyloma, and may be the result of inflammatory changes (cyclitis, ulceration, purulent ophthalmia), or of severe wounds or operations.

Fig. 30. — Anterior staphyloma with synechia.

Synechia.—Adhesion of the iris to the cornea (anterior synechia) or to the lens (posterior synechia).

Tension of the Eye.—Is made out by the surgeon standing in front of the patient, who looks down, by pressing gently with the two fore-fingers through the closed lid. Pressure should be made directly downward, and the two eyes carefully compared. If the sclerotic cannot be indented by moderate pressure, the tension is said to be + 3; if the eye is harder than normal, but can still be indented, the signs + 1 and + 2

used: T — 1; — 2 or — 3 meaning different degrees of low-
tension. The latter is met with in eyes lost from old in-
ımatory changes, in extreme myopia, after wound or rup-
of the cornea or sclerotic, etc. Increased tension occurs
cute and chronic glaucoma, in some cases of iritis, and of
a-ocular tumors. Slight variations in eyeball tension may
ur rapidly, and sometimes a glaucomatous eye becomes of
nal tension with the lapse of time, although its condition
not improved at all as regards vision.

BACTERIOLOGICAL TECHNOLOGY

FOR PHYSICIANS.

DR. C. J. SALOMONSEN.

With 72 Figures in the Text.

AUTHORIZED TRANSLATION FROM THE SECOND REVISED DANISH EDITION

BY

WILLIAM TRELEASE.

BACTERIOLOGICAL TECHNOLOGY.

CHAPTER I.

AUTHOR'S PREFACE.

THE first edition of this text-book was issued in 1885, as a reprint from the Nordiskt Medicinskt Arkiv. The increased size of this new edition is partly due to the addition of an introduction to the microscopic investigation of bacteria; but the active development of bacteriology in the last few years has also necessitated a re-elaboration and extension of all of the chapters.

In the work, I have had two objects in view: the preparation of an outline adapted to bacteriological courses for physicians and veterinary surgeons, and a guide for those who are obliged to take up the subject at home without the assistance of an instructor, yet wish to carry out for themselves the fundamental experiments which are most important for pathology and hygiene. I have, therefore, not attempted to give an exhaustive presentation of the entire technology of the subject, but rather to describe the simplest and most easily managed apparatus and methods, so that the equipment of a home laboratory need not appear too expensive; while I have tried to describe these in a sufficiently elementary and detailed manner.

Those who wish a more comprehensive treatise, are referred to the last edition of Hueppe's "Methoden der Bakterienforschung" (Wiesbaden, 1889). C. J. S.

TRANSLATOR'S PREFACE.

So many works on bacteriology are now accessible, that a new one must possess decided merit to justify its appearance.

The scope of the present little volume is such as to satisfy me that it should fill a place as yet vacant; and the careful treatment of the subject gives rise to the hope that it may find a larger field of usefulness in the English language than could be possible while it was confined to the less-used Danish.

The physician who wishes to read a well-written account of the more important pathogenic bacteria, is further referred to Fraenkel's "Bakterienkunde." The fullest and most reliable attempt at a bacteriological flora, is to be found in Fluegge's "Fermente und Mikroparasiten," which contains much additional information.

W. T.

STERILIZATION.

BACTERIOLOGICAL technology must in the first place put means in our hands for separating the different kinds of bacteria from one another, and cultivating each species in a state of complete purity. Pure cultivation is a necessary condition for a trustworthy study of the morphology and physiology of these microscopic organisms. Unless one has this constantly in mind during his work, he is certain to end in sad confusion; and the short history of bacteriology is only too full of worthless investigations and wrong results, which are to be attributed to the untrustworthiness of the methods employed.

It is well known that the pure cultivation of a single kind of bacteria is surrounded by quite peculiar difficulties, due to the extreme smallness, the large numbers, and the extraordinary distribution, one might almost say omnipresence, of bacteria. Everything which is allowed to stand uncovered in the air for a short time is likely to receive spores capable of germination, which fall on its surface with the dust. Every contact with hands or clothing is attended with the same danger. We must learn first of all to meet and control this accidental and invisible source of contamination, for it is self-evident that all vessels, instruments, fluids, etc., which are to be used in cultures must be clean, not only in the sense in which chemists use the word, but also in the bacteriological sense, or sterile, that is, free from living germs.

Heat is the most generally used means of sterilization, but

it must be used in different ways, and of different degrees, according to the nature of the material to be sterilized, a platinum needle, for example, is best sterilized by heating it to incandescence directly in the flame; but a knife blade, or a pair of scissors, can clearly not be heated to this point. These can only be "flamed," that is, drawn slowly back and forth through the flame, until one is sure that all of their surface has been heated to at least 200° C., so that any germs have been burned.

But it is only exceptionally that glowing or flaming can be employed. If one has to deal with glass-ware, metallic articles, cotton, paper, etc., these are most frequently sterilized in air heated to about 150° C. In the preparation of most fluid and solid culture-media, one can most rapidly and surely reach the desired end by the help of a Papin digester, an "autoclave," in which the sterilization is effected by steam under pressure, at 110 to 120° C.; or one contents himself with using the boiling temperature, either by directly cooking the substance, or by heating it to 100° C., or about that point, by the aid of streaming steam. Occasionally, however, one may have to use a temperature lower than this (60 to 70° C.), to kill germs, for instance where serum is used. In some cases filtration and disinfecting solutions are used as means of sterilizing.

The entire collection of instruments needed for sterilizing, the apparatus and culture-media to be used in the investigations that we shall describe, are, in addition to a common Bunsen gas burner (or alcohól lamp), the following:

1. *A sterilizing oven* in which articles made of glass and metal, cotton, paper, etc., are heated to about 150° C., by means of hot air.

For this purpose one uses in the laboratory a double-walled sheet-iron box 30 cm. high, 35 cm. broad, and 23 cm. deep, with a tube in the top for inserting a thermometer, a door in the side, and with a loose middle piece in the bottom against which the large gas jet constantly plays, and which consequently will burn through after long use, when it is only necessary to put in a new piece of iron.

One can usually get along with less expense by making a serviceable sterilizing oven (Figs. 1, 2) of one of the common cracker boxes (about 24 cm. high, 22 cm. wide, and 24 cm.

deep) to be obtained cheaply of any grocer. In the cover a round hole is to be cut in which a bored cork is fitted to carry a thermometer, registering to 200° C. For ventilation, a small hole is punched in each of the four side-walls close to the top and bottom. In the box is set a four-sided piece of strong sheet-iron, with the sides bent down so as to hold it about 2 cm. from the bottom, so that the objects to be sterilized will not come into immediate contact with the latter. The box is inclosed in a substance which is a poor conductor of heat, felt being usually chosen. One piece covers the lid, and is perfor-

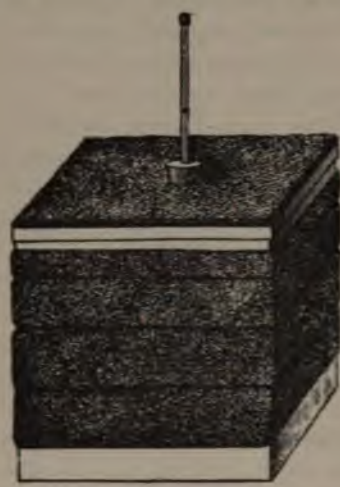

Fig. 1.

Fig. 2.

Figs. 1 and 2.—Oven for sterilization at 150° C., formed of a cracker box surrounded with felt and provided with thermometer and support of iron netting.

ated for the passage of the cork and thermometer. Another piece is chosen long enough to be wrapped around the four sides of the box and wide enough to cover the upper three quarters of these, excepting a small space where the air-holes occur. The lowermost quarter is best left uncovered to avoid scorching or burning the felt. This strip of felt is fastened simply by tying around it tightly a few pieces of cord or wire. The box is set on one or two of the common iron tripods, such as are used in chemical laboratories, and is heated by one or more gas burners. Between these and the bottom of the box, a loose piece of sheet-tin can be placed to prevent burning

through the bottom. If gas is not at hand, a small oil stove with one or two burners can be used.

In comparison with the larger and more expensive ovens provided with ventilators and thermo-regulator, this primitive apparatus offers some inconveniences, but these do not count for much in comparison with its perfect usefulness and extreme cheapness.

Care must be taken to guard the sterilized objects from fresh contamination when they are taken out of the sterilizer. Vessels which are guarded from the penetration of germs, by cotton plugs or otherwise, when it is not especially important to keep the outside free from germs (*e.g.*, flasks and test-tubes) can simply be taken from the oven after they have been heated to 150° C. for half an hour or an hour, and set aside without any other precaution than covering or wrapping them up in paper to prevent them from becoming very dusty. But objects which must be perfectly sterilized, such as watch-glasses, slides, large glass plates, etc., must be carefully wrapped in a couple of thicknesses of thin, firm paper before they are put in the oven. Germs from the air cannot pass through this, and the objects can thus be kept satisfactorily sterile for a long time. It is well to wrap each object in several layers of thin paper, and then to wrap these in larger parcels.

Paper and cotton should be kept as far as possible from the bottom of the oven to prevent them from becoming charred by long heating. Paper and cotton (but not absorbent cotton) assume a yellowish-brown color after being kept at from 140° to 150° C. for a long time, and this discoloration consequently shows that the heat in the sterilizing oven has been sufficient even without the testimony of a thermometer.

2. *The Steam Sterilizer of Koch.*—Sterilization at the boiling temperature can evidently be effected by cooking in water, but since this method is not only inapplicable in many cases, but always more laborious and unreliable than sterilization by streaming steam as introduced by Koch, the latter is now the principal method used when it is desired to sterilize at 100° C.

It will be remembered that two advantages are gained by this: the heat penetrates rapidly into the objects to be sterilized, and steam of this temperature (99° to 100° C. according to altitude) sterilizes much more rapidly than atmospheric air

of the same or a much higher temperature, probably for chemical reasons.

The partly diagrammatic illustration shows the Koch steam apparatus of a simple and cheap form. It consists of a tin

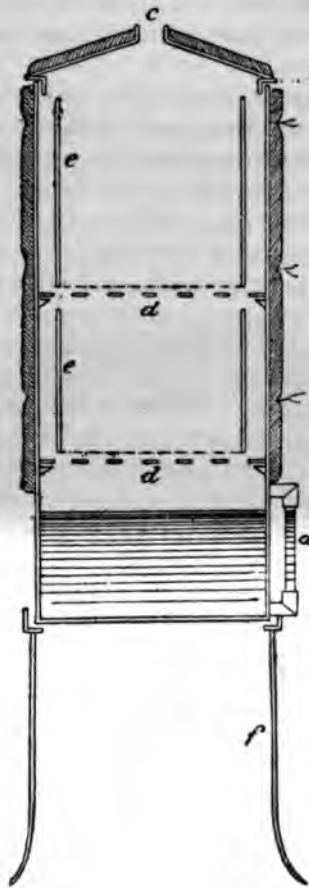

FIG. 3.

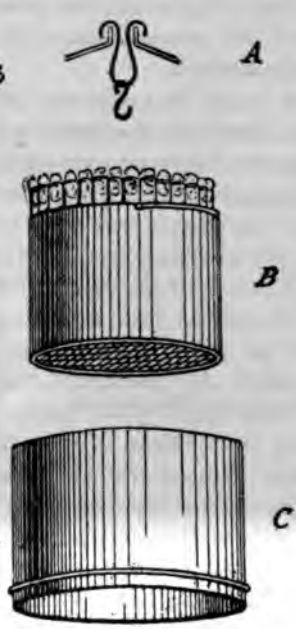

FIG. 4.

FIGS. 3 and 4.—Koch cylinder in its simplest form, with two tin shelves and pails. *A*, Hook for suspending long objects; *B*, tin pail with sieve-bottom, containing plugged test-tubes; *C*, tin cylinder for elongating the apparatus.

cylinder 50 cm. high and 17 cm. in diameter, and is provided with a small glass tube (*a*) fastened by rubber tubing in which the height of the water can be seen from the outside. The absolute size, as well as the proportion between the height

and diameter, can naturally be varied within wide limits and the distance between the shelves is to be adapted to the height of the apparatus, etc., that are to be most frequently sterilized. The bottom, which is to be exposed to the action of the flame, is preferably made of somewhat thicker tin than the sides. The top of the apparatus is closed by a conical lid (*b*) the centre of which is pierced by a short tube (*c*) for the reception of a cork and thermometer. The lid and the side walls, to within 9 cm. of the bottom, are usually covered with felt, though this is not absolutely necessary. Within the cylinder, at a distance of 14 and 30 cm. from the bottom, are placed projecting ledges, on which can be placed two loosely fitting shelves of heavy tin perforated with large holes (*dd*). These serve to support tin pails (*ee*) about 12 cm. high and 14 cm. in diameter, the bottom of which is best made of wide-meshed galvanized iron netting (Fig. 4, *B*). These hold the objects to be sterilized, *e.g.*, test-tubes plugged with cotton in the figure. When it is to be used, the apparatus is placed on a tripod (*f*) of stout strap-iron. The pails are taken out and the cylinder is filled with water to a depth of about 10 cm. The pails with their contents having been set in and the lid with its thermometer put in place, the water is heated to the boiling point. After some time steam will escape freely around the loosely-fitting lid, and the thermometer will also show about 100° C., after which the objects are left in this streaming steam for a longer or shorter time (as a rule, twenty minutes), the time being counted from the moment when the thermometer indicates 100° C. (or the steam begins to escape freely). Most objects which are to be sterilized by steam can be set on the tin shelves without difficulty. Longer objects can be hung in the apparatus after the pails and shelves have been removed. This is most easily done by using a piece of stout brass wire, bent and brought into the opening of the lid (Fig. 4, *A*).

The apparatus can be lengthened when this is necessary by using a tin cylinder, with a projecting collar near its base (Fig. 4, *DC*) to be inserted between the lid and the top of the cylinder. A stop-cock, near the bottom, for drawing off the water, increases the expense of the apparatus somewhat, but adds to its convenience. Moreover, one can easily form such a steam sterilizer from a common kitchen pot. It is only neces-

sary to fit to it a tin cylinder open at the bottom, and furnished with a lid and felt covering, but it is essential to provide this cylinder with a projecting collar at a couple of centimetres from the bottom, by which it rests on the edge of the pot; and it is best to provide it with a couple of rings, by which the cylinder may be tied to the ears of the pot.

A word of explanation should be offered for the omission of the Papin digester in speaking of necessary apparatus for sterilization. There are, indeed, bacillus spores which are able to survive a cooking for several hours in water or free steam, while they are killed after a few moments' heating to 120° C. in the digester, consequently this is the only apparatus in which one can rapidly and surely effect sterilization by a single attempt. Still it is a very expensive piece of apparatus, which is the only reason that it has been omitted. Koch's steam cylinder, on the other hand, is very simple, cheap, and efficient when it is used with care. As a rule the spores of bacilli which always get into our culture media, from water, the air, etc., are not so resistant as those which have been mentioned. Generally, streaming steam at 100° C. will kill them, and experiments from a large number of bacteriological laboratories have long since shown the adequacy of Koch's apparatus. However, in the preparation of his culture apparatus one must always have in mind that some very resistant form may have escaped destruction in the steam, and must make sure of absolute freedom from germs in his culture media by:

a. Cleanliness in the preparation. It is not sufficient to trust to the final sterilization of the materials, but at every step of the preparation one should work cleanly, to lessen the chances of resistant germs entering.

b. Discontinuous Heating.—This method was first applied by Tyndall in 1877 for the sterilization of hay infusion, which is known to contain some of the most resistant bacillus spores, the extraordinary vitality of which renders it impossible to sterilize this substance even by cooking it for some minutes (*cf.* Chapter IV., Section 2). Tyndall reached his method of sterilizing by the following train of thought: When a hay infusion has been boiled for some minutes all of the rod-shaped bacilli, unable to endure this treatment, are dead, while the spores of bacilli (more exactly, of some of them) are still alive.

If now all of these surviving spores are given time to germinate and the infusion is again cooked, it will be completely sterilized, because, when it is heated it contains no spores but only rods. However, as one cannot be sure that all spores have germinated at the same time, this process must usually be repeated several times. Hence it is recommended to submit the filled culture apparatus to steaming twice, with a day intervening. This is especially important for those culture media which, like gelatin, bear only a short cooking.

c. Waiting and Watching.—For greater certainty, the materials treated in this way are allowed to stand for some time before they are used, so that one may be sure that they contain nothing capable of germination. If they are placed in the thermostat at about 30° C., a delay of a couple of days may be looked on as sufficient.

3. *Water Bath for Sterilizing at Temperatures below the Boiling Point.*—Various fluids will not bear being sterilized at 100° C., because at so high a temperature they undergo chemical changes which it is wished to avoid for one reason or another. In such cases the short exposure to a high temperature can be replaced by long maintenance at a lower temperature, until no germ capable of growth remains in the fluids. This method was discovered by Pasteur, and by his advice applied on a large scale in the fabrication of wine ("Pasteurization") to secure sterilization of the wines without at the same time injuring their quality. In what follows we shall make use of the preparation of blood serum according to Koch's directions. Rather complicated and expensive apparatus is often used for this, but one can get along very well with a simple cylindrical water-bath made of tin, such as Koch himself used in his first preparations. The tin receptacle (Fig. 5) is 22 cm. high, and 13 cm. in diameter. At the top it is provided with a collar 1.5 cm. broad. A piece of fine-meshed flexible galvanized iron netting (*a*) serves as a lid, and is fastened by bending its edges under the collar. The temperature of the water is read off on the thermometer (*b*) which projects through a hole in the lid. The bulb of the thermometer is held up several centimetres above the bottom of the cylinder, by another loose piece of wire cloth (*c*) resting upon its edges, which are bent down; when the water has reached a suitable temperature, usually 60° to 70° C., it is easy to hold it at about

the same point for a long time, *e.g.*, a couple of hours, by the use of a small gas or alcohol flame. Though a range of a few degrees can usually be allowed, it is best to keep the temperature under observation. Further directions for the preparation of serum are given later.

4. *Porcelain Filters.*—Even a slight heating often causes in the culture fluid chemical changes which it may be important to avoid. In such cases the germs have been removed by filtration through burnt clay (Klebs), plaster (Pasteur and Miquel), porcelain (Chamberland), or sheet asbestos (Hesse),

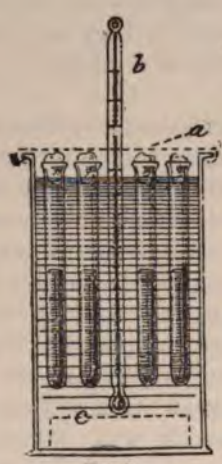

FIG. 5.

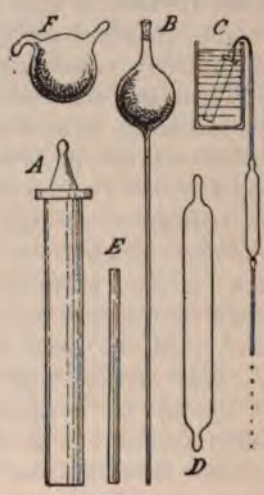

FIG. 6.

FIG. 5.—Water-bath for Sterilization at Lower Temperatures.

FIG. 6.—*A*, Chamberland Filter (× 1/6); *B*, bulb-pipette for collecting the contents of the filter; *E*, small porcelain filter (× 1/6); *F*, reservoir, which can also be used as a culture-vessel; *C* and *D* are explained in the text.

which keep back all of the cells contained in the fluid. As filtration plays a prominent part in the separation of bacteria from their soluble products, we shall here dwell somewhat more fully on the use of

Chamberland's Filter.—This consists of a hollow porcelain cylinder (Fig. 6 *A*), which is closed at the bottom and at the upper end provided with a funnel-shaped glazed end-piece, over which a rubber tube can be pushed. The filter is immersed in the fluid to be sterilized and the upper (open) end is connected with some kind of aspirator. If the fluid to be fil-

tered is in too great quantity to be contained in the cavity of the filter, another receptacle is inserted between the aspirator and filter. An ordinary wash-bottle (Fig. 7) can be used for this purpose; and when the fluid to be sterilized is not too hard to filter, a common bottle aspirator (Fig. 7, *a*) can be employed. The details of the process are then as follows: The open end of the filter is closed by a plug of cotton batting. It is then wrapped in paper and sterilized at 150° C. The open ends of both tubes of the wash-bottle are plugged with cotton, wrapped in paper and sterilized with the filter, as is the plugged wash-bottle. The rubber stopper of the latter (bored

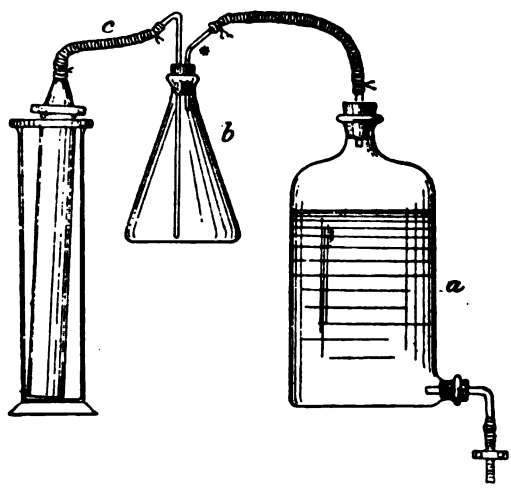

FIG. 7.—Chamberland Filter set up for use, with Aspirator and Wash-bottle Reservoir.

with two holes for the tubes), and the two pieces of firm-walled rubber tubing for connecting the flask with the filter and the aspirator, must be sterilized in some other manner. They are first laid for fifteen minutes in a $\frac{1}{10}$ per cent sublimate solution, rinsed in sterilized distilled water, plugged with cotton that has been previously sterilized by dry heat, and after wrapping in paper they are steamed for fifteen minutes. After this has been done, the filter is put together as rapidly as possible, and with the ulmost cleanliness, the fingers being first washed in sublimate. The glass tubes are fixed in the rubber stopper, and this is fitted to the wash-bottle after removing the plug from the latter with sterilized forceps. The long

tube is then joined to the filter by one piece of rubber tubing after removal of its cotton plug. The only plug left in place is that at * of Figure 7. The entire apparatus is now steamed for ten minutes, after which it can be used. For additional safety, it is usually customary after the last sterilization to bind the rubber tubing fast to the filter and glass tubes by cord, or better still by previously glowed coarse brass wire, which is tightly wound by the use of pliers.

If instead of the common wash-bottle, a so-called Pasteur flask, made entirely of glass, is used (*cf.* Chapter XI.), the preparations for filtering are very much simplified. It is also evident that if an autoclave is at hand the preparatory sterilization, as well as the rapid and careful setting up of the apparatus can be dispensed with. Without any especial precautions the glass and rubber parts can be joined and then sterilized in a few moments at 120° C.

Figure 7 shows the apparatus in use. The filter is immersed in a relatively narrow glass cylinder, which contains the fluid to be filtered, as this sinks in the glass it is tipped so as to use all of the filtering surface and to prevent air from being sucked through, though this is also sterilized in the passage through the filter. The simple aspirator (*a*) is sufficient, when one has not to deal with fluids that are hard to filter. The bubbling of air back through the aspirator, and the consequent hindrance to filtration, is avoided by regulating the size of the escape tube by a pinch-cock. In other cases, or when the filtering must be done rapidly, more powerful suction is employed, *e.g.*, the small air pump recommended by Chamberland (Fig. 8, *a*), or a filter-pump worked by water. If the filtration is difficult and a powerful pump is used, care must be taken that the walls of the flask are strong enough to bear the atmospheric pressure. In such cases it is customary to use a thick-walled flask instead of a common wash-bottle, and under these circumstances exceptional use may be made of a lead tube within the rubber tubing. After repeated sterilizing by steam, even thick-walled rubber tubing becomes too much softened for further use.

When the wash-bottle (*b*) is filled with the clear filtrate, it is first loosened from the aspirator, then the tube (*c*) is fastened by a clamp or glass plug, after which the flask can be separated from the filter and its contents kept sterile. The

filtrate remaining in the cavity of the filter can be saved, by pouring it into one or more sterile vessels, *e.g.*, culture tubes, as soon as the filter is opened. This is best done by using a pipette (Fig. 6, *B*), plugged at the top with cotton, while the tube below the bulb is long enough to reach the bottom of the filter and slender enough to pass through its opening. Before use, it is hermetically sealed, sterilized, and passed through the flame like an ordinary Pasteur pipette, of which, indeed, it is only an enlarged edition (*cf.* Fig. 22).

After being used, the Chamberland filter is cleaned according to circumstances, by simply brushing off the surface and washing it in water, or by the additional use of chemicals, *e.g.*, disinfectants. Occasionally it may also be desirable or necessary to rinse its pores out thoroughly with water, before it is dried and again sterilized. This is most quickly accomplished (Fig. 6, *C*), in the following way: the filter is filled with water and immersed in a large vessel of water, which is placed quite high, as on a shelf or cupboard. A rubber tube several feet long is attached to its open end. Somewhere in this a glass tube (Fig. 6, *D*), filled with water is inserted. Before putting together, the filter and tube are both filled with water.

When one has to do with small quantities of fluid the small thick-walled filter (Fig. 6, *E*) can be used. This is 15 cm. long, with a cavity 2 mm. in diameter. These were first used in Pasteur's laboratory, inserted in a filtering apparatus of special construction, but they can be used in the same manner as the larger ones, by fastening a rubber tube to the upper end with copper wire. A strong suction apparatus is needed for this. The small bulb (Fig. 6, *F*) is intended to be used as a receiver of filtered fluid (Fig. 8) and also without special change, as a culture vessel, with tubular plug (*cf.* Chapter II., p. 455).

It must be remembered that even filtration through porcelain does not always avoid the chemical modification of fluids, since the filter may hold back certain compounds, as well as the germs. If organic culture fluids must be absolutely unchanged, and at the same time free from germs, it is necessary to do without all sterilization, in which case they are to be collected or prepared with such care that all contaminations from their surroundings are avoided. Blood and urine,

for instance, are drawn directly from the heart, veins, or bladder with antiseptic precautions. The preparation of originally sterile infusions is further briefly discussed in Chapter XI.

5. *Disinfecting Solutions.*—As a help in sterilization, it is usual to have at hand a large quantity of corrosive sublimate solution (1 or 2 : 1,000), which is not only used in preparing some sorts of culture media, *e.g.*, potatoes (see Chapter III.), but in many other cases, for cleansing the hands, instruments, morbid material, etc. If well water is used instead of distilled water in making this solution, care must be taken that no precipitate of insoluble mercurial salts is formed, or the fluid

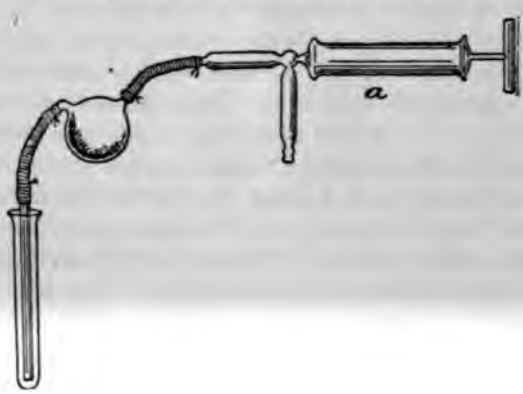

FIG. 8.—Small Porcelain Filter joined to Bulb-reservoir and Air-pump (*a*).

will possess no disinfecting value. To prevent this, a small quantity of acetic acid may be added to the well water. Fürbringer recommends 0.5 gram to each litre of 0.1 per cent solution. Carbolic acid solutions of various strengths are also to be kept ready for use.

CHAPTER II.

COMMON CULTURE-APPARATUS.

THE principal requirements of a culture-apparatus in which pure cultures are to be conveniently and surely obtained are the following: Besides being durable, simple, handy, and cheap, it must be easily sterilized with its contents, and so that it can be opened for inoculation and again closed without much danger of infection from the air. It must also be so closed that the entrance of foreign germs is impossible, while free access of the air is permitted (except when anaerobic forms are to be cultivated). This is effected by the use of cotton batting, which allows a sufficient circulation of air while filtering the germs from this.

The apparatus to be recommended for simply keeping a pure culture is the following:

1. Test-tubes and flasks plugged with cotton. One can commonly use:

a. Test-tubes of any size. The use of small tubes (*e.g.*, 13 cm. long, and 1 cm. in diameter) is to be recommended. A considerable quantity of the culture material is then saved. Since the heating of these glasses is generally effected in the steam sterilizer and not directly over the flame, their walls need not necessarily be so thin as those of chemical test-tubes, and consequently it may be best to order those with especially thick walls, entirely without a flange, so that the cotton plug may fit better to the edge.

The test-tubes are first carefully cleaned with common distilled water, and then plugged in the following manner: Good cotton batting (not absorbent cotton) is pressed with a pair of forceps (or twisted by the hand) into the mouth of the test-tube in sufficient quantity to form a firm, tightly fitting plug, which reaches a couple of centimetres into the tube, while part of it projects and frays out over the edge. The

plug must be both firm and tightly fitting, yet capable of removal and reinsertion (by a twisting motion) without much difficulty. When the test-tubes have been plugged, they are put in a small four-sided basket, made of wire-cloth, of a suitable size for the oven, and sterilized at 150° C.

If it is wished to make use of a larger surface than is available when a test-tube is used, even when it is obliquely placed (Fig. 9, II.), recourse is had to:

b. Small Conical Flasks.—(Erlenmeyer flasks) of the form shown in Fig. 9, VII., and holding about 100 cc.

FIG. 9.—Various Culture-glasses with Cotton Plugs (*I., II., VII.*), or Plugged Caps (*III.—VI.*)

c. Small Medicine Bottles (30 gm.) are conveniently used in the same way, and the surface of the gelatin in them can also be increased by placing them in an oblique position while it is hardening. They have the advantage over test-tubes that they may be stood upright without the use of a rack.

Any of these receptacles can be used for cultures in either solid or fluid media. A fault common to them is that they are all relatively wide mouthed, so that the removal of the plug leads to a certain danger of contamination, especially from dust which has settled on the plugs when they have stood for some time. This can be obviated by tying a couple

of layers of filter paper over the cotton plug (Fig. 9, VII.), which is especially recommended when large flasks are used. For greater safety, the part of the cotton projecting beyond the tube can be singed off just before use. Both these precautions are less necessary when solid media are used, so that the tube or flask can be inverted while the plug is removed and inoculation effected. They are more important when the contents of the vessels are fluid. Much greater safety is secured by the tubular cotton plug of the author which is described later.

2. *Vessels with Tubular Plugs.*—When I began in 1879–80 the pure culture of a large number of putrefactive bacteria, which had been isolated by the capillary-tube method, I first used stoppers in the form of short pieces of rubber tubing, in one end of which small sterilized tampons of cotton were fixed. The vessels which were closed by these tubular stoppers were larger and smaller flask-shaped or test-tube-shaped glasses, which had a short and broad slightly conical neck, with relatively narrow mouth (2 to 4 mm.) over which the rubber tube could be slipped (Fig. 9, III.–V.).

The tubular stoppers are prepared as follows: The cotton is sterilized at 150° C. The rubber tube, 6 to 8 cm. long, is sterilized by steam, wrapped in paper. It should be a little larger than the top and a little smaller than the bottom of the conical neck it is to fit. After cooling, the tubes are unwrapped, and by the aid of small forceps, half filled with tampons of the sterilized cotton, which must be so large and firm that they bulge the tube slightly (Fig. 9, V.). The advantages of these stoppers are, obviously: *a.* In opening and closing the flasks the cotton and the dust that has collected on it are not touched. *b.* The apparatus is opened and closed at a point where its surface can always be easily freed from dust. *c.* The opening through which inoculation is effected is smaller than with test-tubes.

The same principle was afterward applied in a more adequate form in the so-called Pasteur or Chamberland flasks (Fig. 10) which are much used in Pasteur's laboratory. The cap of these is not made of rubber but of glass, and is closely fitted to the neck by grinding. Unlike the flasks with rubber tubes, they can be sterilized entire at 150° C., and hence, as a rule, are preferable to the latter. The flasks and caps, which

belong together, are numbered correspondingly with Brunswick black (Fig. 10).

Notwithstanding the decided superiority of the tubular cap over the simple cotton plug, the latter as a rule is used even in fluid cultures; but the rubber cap is always useful when a narrow tube is to be plugged with cotton (*cf.* Fig. 56 and Fig. 58). By means of a bored rubber stopper, a tubular cap can be adapted to any flask (Fig. 9, VI.).

3. *Other Culture Apparatus.*—A pair of small glass trays (3 to 5 cm. in diameter) can be used for cultures, one serving as a lid for the other (Fig. 13). They have the advantage over

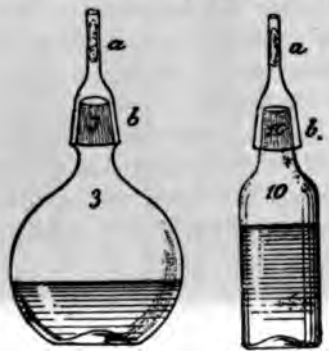

FIG. 10.—Pasteur-Chamberland Flask.

FIG. 11.—Glass Box for Soyka's Museum Cultures.

vessels plugged with cotton, that their contents are more easily accessible, even for microscopic examination, but they are less secure against foreign germs.

A far more reliable security against contamination is afforded by glass boxes with overlapping and ground covers (Fig. 11), such as Soyka uses for his hermetically sealed "museum cultures" (*cf.* Chapter VI.).

A number of other contrivances for cultures adapted to particular purposes will be described later. The apparatus for cultivating anaerobic bacteria, and for cultivating bacteria under the microscope, are for convenience left for treatment in later chapters, devoted to these subjects.

CHAPTER III.

CULTURE-MEDIA, AND THEIR INTRODUCTION INTO TEST-TUBES, FLASKS, ETC.

IT would be useless to mention the enormous number of solutions, infusions, etc., which have been applied advantageously in various bacteriological investigations, and moreover it may obviously be necessary for each experimenter to use the most dissimilar culture-media, and to vary them, within wide limits, by the addition or removal of one substance or another according to the object of the investigation. Directions are given here for the preparation of only such fluid and solid media as have been found especially useful in the study of pathogenic micro-organisms during the last few years. They are commonly made in the conical Erlenmeyer flasks (Fig. 10, VII.). These conical flasks will be frequently mentioned in the following pages, where they are designated as large, medium, and small, holding respectively 1,500, 500, or 100 gm.

A. FLUID MEDIA.

1. *Flesh Water.*—Even the simple decoction, made by cooking meat in water, with an acid reaction, affords a good nutrient substance for a large number of bacterian forms, but when it is neutralized by the addition of a little sodium carbonate, a fluid is obtained in which a large number of the most important pathogenic germs yet known, also thrive. For the preparation of broth, different kinds of meat are used according to circumstances, and the procedure is somewhat different in the various laboratories. This is worth noting, because we must be prepared to recognize in our present imperfect knowledge concerning the nutrition of bacteria, that slight variations in the preparation may give rise to differences in the results of cultures.

The two most common methods of preparation are the following:

a. ***Bouillon*** (B).—A pound of lean, scraped, or finely chopped beef is placed in an enamelled kettle, or a large flask, with a litre of distilled water. The mixture is cooked for half an hour and filtered. The filtrate is neutralized or rendered slightly alkaline by adding to it, drop by drop, a solution of carbonate or phosphate of sodium. It is then again boiled for half an hour, by which time the insoluble albuminoids are coagulated (C. Fraenkel), after which it is allowed to cool when the fat solidifies. Having been once more filtered, the clear broth is filled into small vessels [usually medicine bottles or test-tubes], plugged with cotton, *cf.* p. 460), in which it is finally sterilized in the steam-cylinder for a quarter of an hour. For greater security, it is again sterilized on the following day (disconnected sterilization, *cf.* p. 446). With each new cooking, the clear filtered broth may become clouded, but the turbidity disappears on cooling, otherwise it is necessary to repeat the cooking and filtration several times, until the fluid is obtained perfectly clear. This decoction of meat is known in the laboratory as bouillon (B) in contrast with the following.

b. ***Flesh water*** (K), in the more restricted sense. A pound of chopped lean beef is covered with a litre of water and set in an ice-chest for twenty-four hours, after which it is thoroughly shaken and filtered through muslin, the juices being squeezed out from the meat. In this way a litre of flesh extract is obtained, which is then cooked, filtered, rendered slightly alkaline, etc., as before.

The addition of 0.5 per cent of table salt increases the value of broth and flesh extract as a culture fluid for a number of bacteria (Miquel).

The addition of five per cent of glycerin (before the last sterilization) gives an excellent medium for the tubercle bacillus (Roux and Nocard).

Obviously, there may also be occasion for varying the composition of the bouillon by the addition of various other substances, as peptone, cane or grape-sugar, acetic acid, etc.

Neutral flesh water can also be obtained by the solution in water of a suitable quantity of some meat-extracts, followed by very careful "disconnected" sterilization (because of the

numerous resistant germs often present in these extracts), neutralization, filtration, etc.

c. Liebig's extract (E), 5 gm. to a litre of water, is to be recommended, and especially

d. Cibil's extract (C), 20 gm. to a litre of water

Of other nutrient fluids, only the following, of proved and recognized value, will be named:

2. Aqueous decoction of liver, lungs, and other viscera.

3. Neutralized or slightly alkaline wine (used at one time by Pasteur) in the pure cultivation of the bacillus of splenic fever, on a large scale.

4. Infusion or decoction of wheat, hay, cabbage.

5. Yeast-water, a filtered and sterilized decoction of 100 parts water to 10 parts compressed yeast.

For the cultivation of yeast and moulds, the following are especially adapted:

6. Beer-wort, a decoction of dried and pulverized malt, obtainable at every brewery. This must be cooked for an hour and then filtered, before use, but it is hard to obtain it clear.

7. Decoction of horse dung (and of the excrement of other herbivora). One part of fresh horse dung is mixed, by the use of a glass rod, with three parts of water, set in a cool place for twenty-four hours, after which the mixture is cooked for an hour, and filtered through a double filter, which is a very slow process (unless a filter pump is used). The filtrate is again cooked for some time and if necessary refiltered, after which it is filled into small receptacles, sterilized in the steam-cylinder, and boiled twice for fifteen minutes, with a day between.

8. Decoction of prunes, which is best prepared as follows: The prunes are allowed to stand for a day in a little water, in which they are then cooked carefully, so that they remain unbroken. The fluid is afterward filtered and boiled down somewhat. In some cases it may be desirable to reduce the acidity of the decoction by the addition of sodium phosphate.

9. Decoction of other dried fruits, *e. g.*, raisins, dried pears, etc.

The horse dung, prunes, raisins, etc., used in making these decoctions, may be preserved in a sterile condition, for use as solid media in the culture of moulds, yeasts, etc.

A neutral or very slightly acid beer-wort is especially

adapted to the culture of Mucorini; while for the various species of Aspergillus a simple acid mixture of wort and prune-juice is an especially good medium, as O. Joh. Olson has told me. A mixture of the three liquids numbered 6, 7, and 8, may at times be useful. The reader is referred to Chapter XI. for directions for collecting and preparing primarily sterile nutrient fluids.

When a large quantity of culture fluid has been prepared, it is distributed in several medicine bottles (or Erlenmeyer flasks) holding one or two hundred grams, previously plugged with cotton and sterilized at 150° C. In these smaller vessels the fluid is finally sterilized in the steam cylinder for five to fifteen minutes on two sucessive days. It can then be preserved as long as is wished, in a dry place, provided the flasks are well plugged. The safest plan is to use a large cotton plug, and to tie over it several layers of filter paper (or to cover it with a sterilized thin rubber cap, such as the Germans now use extensively).

Formerly "Pasteur's fluid" (pure rock-candy, 10 gm; ammonium acetate, 0.1 gm.; and the ashes of 1 gm. yeast, all dissolved in distilled water), "Mayer's fluid," or "Cohn's fluid" (potassium phosphate, 0.5 gm.; magnesium sulphate, 0.5 gm.; tribasic phosphate of potassium, 0.5 gm.; acetate of ammonium, 1 gm.; water, 100 gm.) were used. These fluids are little suited to the cultivation of bacteria. It must also be remembered that Pasteur by no means introduced such mineral solutions as suitable nutrient fluids for microbes, but to show (1858) that yeast cells can produce albuminoids from a carbo-hydrate and an inorganic nitrogenous compound, when the necessary ash-constituents are also present.

B. Solid Media.

The systematic use of solid nutrient media, especially of nutrient gelatin (Robert Koch, 1881), marks a turning point in the history of bacteriological technology. Brefeld had previously employed nutrient gelatin, but essentially only to check the drying of slide-cultures. The starting point for Koch's important discovery was the long-known fact that the cut surface of a cooked potato, laid away for some time exposed to the air, becomes the seat of large and small colonies of mould,

yeast, and bacteria, the last two of which often occur as small distinct, slimy colonies of various colors. Each colony, as a rule, contains only one form of yeast or bacteria, which has developed from a germ that fell from the air and found in the potato a favorable soil for its growth (first noticed by Hoffmann, in 1869, and utilized by Schroeter in 1872, in his cultivation of pigment bacteria). If we imagine these germs to have fallen, not on the solid surface of the potato, but on an equally large surface of some fluid in which they could thrive as well, it is easily seen that the several forms would have run together after a short time, motile and quiescent being mixed together. Some of the germs which succeeded in developing upon the potato, where they found space undisturbed by other colonies, would, perhaps, have failed to develop at all in the fluid, yielding to others in the struggle for existence. The same germs which in the fluid produced a motley tangle of intermingled forms, gave a series of well-separated colonies, on the solid medium.

When Koch had become aware of the extraordinary advantage offered by cultures on solid media over those in fluids, he sought to give various useful culture fluids a solid form, and he succeeded in doing this by gelatinizing them, in the manner to be described. The "nutrient gelatins" so prepared, have the advantage over potato, that their chemical composition can be varied within wide limits, so that solid culture media may be produced for such bacteria as cannot be found on potato. They are, further, transparent, which renders possible the observation of the growth of bacteria within the gelatin, as well as the microscopic examination of the culture. Finally, they are liquefiable at a low temperature, which is of decided value for their application to the isolation of the different bacterian germs.

A low melting point, however, limits in some ways the usefulness of gelatins, since it makes it impossible to employ them for cultures at much above 20° C. Koch therefore introduced for such cultures a second gelatinizing substance, agar-agar, which remains solid at the highest temperatures used for culture investigations. The same remark applies to sterilized blood-serum, which Koch found a method of preparing.

It was said above that the introduction of solid culture-

media marks a turning point in the history of bacteriological technology. This is doubly true. In the first place, it has become possible by them to surely and easily isolate, and cultivate in a state of purity, the various bacterian forms, as is evident from what has been said, and as will be shown more in detail in the next chapter. But the introduction of solid media has also in many ways simplified bacteriological work, making it possible to work with far simpler apparatus, and at the same time with far better control and far greater certainty, aside from other reasons, because any accidentally introduced foreign germ manifests itself more readily when it forms a limited colony on or in the gelatin, than when its progeny in a fluid become scattered and mixed among all the other bacteria.

It must not be forgotten, however, that there are also limits to cultivation upon solid media, and that it by no means necessarily renders fluid cultures superfluous; so that the same care is due to the technique of the latter as formerly. To mention a single instance of many: it is obvious that experiments concerning the fermentation products of bacteria, and their nutrition, may demand the use of culture fluids which have a very simple chemical composition, but which would be changed into very troublesome and complex mixtures by the addition of gelatin or agar-agar. In addition to this, the usefulness of a culture fluid for certain bacteria is at times lessened or destroyed by the addition of gelatin, etc.

1. *Boiled Potato.*—According to circumstances, the preparation and application of potatoes varies a little, so that one either:

1. Simply cuts them in two, and lays them in a moist chamber. The problem in preparing them is first and chiefly, to remove or sterilize the dirt adhering to them, which always contains large numbers of particularly resistant bacillus spores. To this end as clean and smooth-skinned potatoes as possible are selected. Then they are repeatedly washed in water, and any remaining dirt is carefully scrubbed off under water, with a brush. By the use of a pointed knife any diseased or injured parts of the skin, as well as the changed parts of the underlying parenchyma, are removed. The potatoes are then laid for some time in a 0.1 per cent. sublimate solution, wrapped singly, without being dried, in thin wrapping paper, and ex-

posed for half an hour to streaming steam at 100° C. After twenty-four hours the steaming is repeated for fifteen minutes and the potatoes are ready for use. They are taken from the paper one at a time, held between thumb and one finger of the left hand, which has previously been washed in sublimate, and are halved by a table knife that has been carefully sterilized by being drawn several times through the flame, or by prolonged heating at 150° C. (wrapped in paper in the sterilizing oven). The halves are then quickly laid with the cut faces up, in a moist chamber, *e.g.*, under a bell glass set on an earthen plate (or in the flat pairs of trays similar to Fig. 13, but about 20 cm. in diameter which, though they cannot be so easily obtained, are safer and have the advantage that they can be set away one on top of the other). Dish and bell glass have first been carefully cleaned in water and rinsed in 1.0 per cent sublimate; and one or two thicknesses of filter

Fig. 12.

Fig. 13.

Figs. 12 and 13.—Shallow and Deep Glass Trays in Pairs, the Larger serving as a Lid for the Smaller.

paper moistened in the same solution have been laid in the bottom of the plate. A potato cooked and divided in this manner, placed under a bell glass is one of the simplest arrangements for cultivating bacteria, but it is always exposed to contamination by germs from the air. This is avoided by:

2. Dividing the potatoes into prismatic pieces (or cylinders, by the use of a small-sized tin cutter made like common apple corers) and putting these in plugged test-tubes. In this case it is only necessary to cleanse the surface of the potato with brush and sublimate solution. After the potatoes have been steamed once for five minutes, they are pared and with sterile instruments cut into pieces which are quickly placed in the test-tubes already sterilized in the usual way, after which they are steamed for a quarter of an hour.

3. Nicer cultures are obtained by cutting the cooked and pared potato into round discs, which are laid in the bottom of a small pair of glass trays (Fig. 13, *cf.* Fig. 11, as well as Soyka's museum cultures), which after being wrapped in paper

are then steamed for fifteen minutes. Such discs are best cut out by aid of a small tin ring.

4. Potato broth prepared by mashing pared boiled potatoes and adding a proper amount of water can be occasionally used with advantage, if an especially large culture surface is desired.

2. *Gelatinized Media.*—If we desire, according to Koch's directions, to change our different culture fluids into solid and transpsarent but liqueflable substances we make use of the following:

a. Gelatin.—The finest French gelatin, which comes in thin oblong sheets of about 2.5 gm. weight, is used. Five, or commonly ten, per cent of this is added to the nutrient fluid, dissolved, cooked, rendered slightly alkaline, cleared, filtered, poured into smaller vessels and steamed twice with a day's interval.

b. Agar-agar (The Asiatic name of several peculiar gelatinous algæ, which grow in the Indian Archipelago and come into the market, dried in yellowish cartilaginous strips [or spongy prisms]).—When cooked in water this forms a stiff jelly and can be added to the various culture fluids in a quantity of 1 to 2 per cent, precisely like gelatin. As a rule we use 1.5 per cent, which is dissolved by long cooking and rendered slightly alkaline, after which it is cleared, filtered, etc.

In passing to a fuller description of the preparation of the gelatinizing substances, we must dwell briefly on the advantages and disadvantages attending the use of each. Agar-agar was introduced by Koch, as above indicated: (*a*) because it melts at a much higher temperature than gelatin, and can therefore be used for cultures on a solid medium at a higher temperature (30°–40° C. or higher); (*b*) it has also the advantage as compared with gelatin that it endures cooking for a longer time without diminution of its gelatinizing power; (*c*) there are many bacteria which liquefy gelatin in their growth, but do not affect agar in this manner, which in many cases is a great advantage, especially in isolation-cultures. On the other hand, it must be said: (*a*) that because of its low melting point, gelatin is better adapted to the isolation of germs; (*b*) it gives a filtrate as clear as water, while it is very difficult, not to say impossible, to get perfectly clear nutrient agar; (*c*) the difference between the mode of growth of different

bacteria shows far more clearly in gelatin than in agar, so that two species which give in gelatin colonies of very different appearance, sometimes appear identical when they have grown in agar.

c. Agar-Gelatin.—To Jensen is due the credit of combining the good qualities of both media, and avoiding their disadvantages, by adding to culture fluids 5 per cent of gelatin, and 0.75 per cent of agar. The introduction of this mixture marks a real advance, and it is worthy of use as almost the chief culture-medium, since it is easily filtered clear, and liquefiable at so low a temperature that it can be used without difficulty for plate-cultures, though it remains solid at 30°–40° C.

d. Irish-Moss (Chondrus crispus), rarely used.—Neisser recommends a strength of 2.5 per cent.

The preparation of gelatins, agars, and agar-gelatins, is effected essentially in the same manner, so that a single description will suffice for all. But the length of time during which the solutions can be kept at the boiling point for sterilization, cleaning, etc., must be relatively short for those containing gelatin, which otherwise loses its power of solidifying. Agar, on the other hand, endures long cooking, while for agar-gelatin, a golden mean is kept. Gelatin, as a rule, is cooked ten minutes before filtration, and ten minutes after. Agar is best cooked forty-five minutes before, and a like time after; and agar-gelatin twenty minutes before and thirty minutes after filtering. Further than this, only clarifying and filtering demand special mention.

Clarifying.—When the nutrient jelly has cooked long enough, it is allowed to cool to somewhere about 50° C. An egg is then broken into 100 gm. water, and gradually added to the cooled but still fluid mixture, with which it is thoroughly incorporated. For a litre of jelly, the entire egg is used, a correspondingly smaller quantity being used for less than a litre. When the mixture is again heated to the boiling point, the white of egg is precipitated in a large yellowish curd, floating in a perfectly clear fluid. After cooking for some time, the next step is proceeded to—

Filtering.—This must necessarily be done while the jelly is still warm. If little is to be filtered, it is merely necessary to heat it up well before pouring it over the filter, so that,

notwithstanding the cooling, it will remain fluid long enough for all to run through. But in this case, both the funnel and flask need to be first warmed. It is very easy to warm and sterilize flask, funnel, and filter, as well as to moisten the latter, in the manner shown in Fig. 14. A layer of water one or two centimetres deep is poured in the flask, and the funnel and filter are set in its mouth, the top of the funnel being covered with several thicknesses of filter paper, over which a plate of zinc or asbestos is laid (glass is apt to break). By heating the water to the boiling point for a few minutes, everything is sterilized, warmed, and moistened, in a single operation. While the water is still hot, it is poured out, and filtration can begin; the funnel being kept covered with a zinc or asbestos plate which prevents cooling to a considerable extent.

Fig. 14.—Simple Filtering Arrangement.

When larger quantities (*e.g.*, a litre) are to be filtered at once, there is danger that the gelatin may stiffen before the completion of the process, even though it was at first almost boiling. This is prevented by using a hot-water funnel (Fig. 15) a double-walled water bath with a projecting arm at *b*. The apparatus is filled with water through the hole *a*, and is kept warm throughout the filtration by means of a flame set under *b*. Such a double-walled funnel can be made by any tinner, and is far more convenient than the single-walled Plantamour funnel supplied by dealers in apparatus, since the latter must be plugged with a perforated rubber stopper at *c*, as the glass funnel limits the water on the inner side. To prevent too many germs from falling from the air into the flask, a little sterile cotton is stuffed into the mouth of the latter, about the tube of the funnel.

As examples, the preparation of the three most frequently-used nutrient jellies is given in detail. Other combinations (*e.g.*, C. A. G.) are also to be recommended.

C. G. *Cibil's Gelatin.*—20 gm. Cibil's extract is added to 1 litre of distilled water, in which 100 gm. gelatin is then dissolved. Heat till all is dissolved. Render slightly alkaline by addition of sodium carbonate. Boil for ten minutes.

Cool to 50° C. Clarify, as indicated above. Cook again for ten minutes. Filter through two thicknesses of paper in the hot-water funnel. Pour into smaller vessels, and sterilize for a short time in the steam cylinder on two or three successsive days.

E. P. A. *Peptonized Agar.*—5 gm. Liebig's extract; 30 gm. peptone; 5 gm. cane-sugar; 15 gm. agar; 1 litre distilled water. Cook for an hour, render slightly alkaline, and cool to below 60° C. Clarify, cook again for at least an hour, fill into bottles or test-tubes, and steam for ten minutes on each of two or

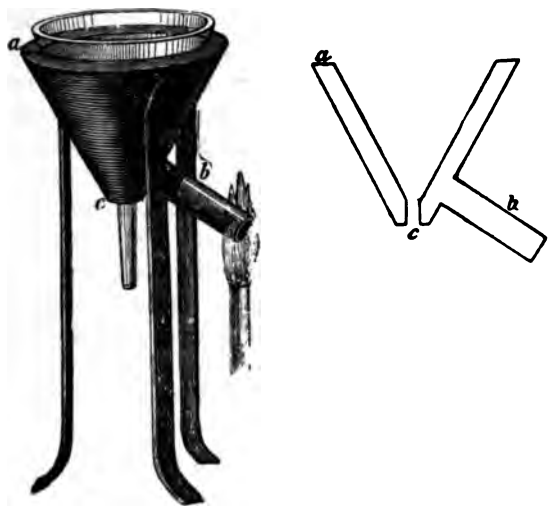

Fig. 15.—Plantamour Hot-water Funnel, for use with Gelatin and Agar.

three successive days. If 5 per cent of sterile glycerin is added to this agar, and the whole neutralized, it forms the glycerin B. P. A. recommended by Roux and Nocard for the cultivation of tubercle bacilli. This is far easier to prepare than serum, which is used for the same purpose, *cf. infra,* p. 468 et seq. and 471.

K. P. A. G. *Peptonized Agar-Gelatin.*—To a litre of filtered flesh-water (pp. 457, 458) add 5 gm. table salt, 10 gm. peptone, 50 gm. gelatin, and 7.5 gm. agar. Treat like E. P. A., except that it is to be cooked each time only 20 to 30 minutes. It is safest before final filtration to filter a little into a test-tube and see if it remains clear after boiling 10 to 15 minutes.

From my experiments, jellies made according to Mahn, by the use of two per cent of Cibil's extract (C. G.—C. A.—C. G.) afford quite as good a medium for many sorts of bacteria as the far more expensive peptonized flesh-water or meat gelatins, with or without sugar.

For the cultivation of moulds or yeasts, jellies are prepared by adding G. or A. to the nutrient fluids named above. Especially to be recommended, are:—

Beer-Wort Agar (B. A.), prepared of equal parts wort and water, with 1.5 per cent agar.

Raisin Gelatin (R. G.), a decoction of 250 gm. raisins in a litre of water, to which is added 10 per cent of gelatin.

3. *Serum.*—Some large glass jars (*e.g.*, pickle-jars—*cf.* Fig. 63) are tied up in three layers of paper, and sterilized at 140°. They are filled with blood from oxen, calves, or horses (lamb's blood is not to be recommended), collected during the slaughtering of the animal, with as great cleanliness as can be obtained in a slaughter house. Care must be taken to avoid shaking the jars, and they are at once set away to coagulate, preferably in cold water. After this, they are kept in a cold place (best of all an ice-box), for 24 to 36 hours. The serum which has now separated out, is transferred in small quantities into plugged and sterilized test-tubes, by aid of a pipette that has been carefully sterilized. The greatest possible care is taken throughout, since any contamination will be more fatal here than in preparing the other culture media, because the final sterilization must be effected at a low temperature and consequently in an incomplete manner. Wetting the inside of the test-tubes toward the top with serum is especially to be avoided, as this part of the tube cannot be immersed in the water during the subsequent heating. The water bath (Fig. 4) is now filled with the test-tubes containing serum, and heated until the thermometer indicates 58° to 60° C., at which temperature it is kept for a little over an hour, by means of a small flame. This is repeated daily, for a week. The serum treated in this manner has become perceptibly clearer than it was originally, a small amount of whitish precipitate has separated, and a thin oily layer (of cholesterin) floats on the surface. All of the less resistant germs are destroyed by the heating.

It remains to solidify the serum without loss of its tran-

parency. Koch effects this by prolonged heating at 68° C. The water bath is brought up to this point and carefully kept there during the process. According to the peculiarities of different lots of blood, the time required for solidifying serum varies from one to several (6 to 8) hours, so that it is necessary to examine a couple of tubes from time to time to see if the coagulation has begun. The heating is stopped when it becomes easy to invert the test-tube without loosening the serum, which is now an amber-yellow jelly, in all cases sufficiently clear in transmitted light to permit observation of the peculiarities of cultures growing along inoculation punctures made in it. The fewer red corpuscles originally present in the serum, the clearer and more attractive it becomes after coagulation; but use can be made of a somewhat red serum, especially for cultures on the surface.

The last heating at about 70° C. not only gelatinizes the serum, but also naturally contributes to a complete sterilization; yet one can only be sure of having killed all germs by convincing himself that the tubes remain free from bacteria after standing for some time, a couple of weeks, at the temperature of the room, or three or four days in the brood-oven at 30° C. (*Cf.* Chapter VI.)

An inconvenience in the use of the water bath for sterilizing and coagulating serum, already indicated, is that the cotton plugs and the upper part of the tubes, which project above the water, are not exposed to so high a temperature as the thermometer shows. This is avoided by using, instead of the water bath, a common hot chamber of the sort indicated in Chapter VI., such as it is always necessary to have for use as a brood-oven.

If it is desired to solidify the serum with a large oblique surface (Fig. 5, II.), the test-tubes must be laid in the chamber in a nearly horizontal position. They are best put in a flat box which can be obliquely set in the brood-oven.

Koch uses for this purpose a shallow, quadrangular thermostat covered with glass and felt. This is shown in section in Fig. 16. The bottom of this is 30 cm. square (inside measure) and the layer of water between the double walls is 6 cm. deep in the bottom (*aa*) and 3 cm. wide at the sides (*bb*). The projecting edge of the outside wall (*c*) rises a cm. above the rest and so incloses a space for a cover consisting of a square

plate of glass (*d*) (which renders possible a quick observation of the temperature and the condition of the serum), and a sheet of felt (*e*) which is a poor conductor. Water is poured in through the tube (*f*), while air is allowed to escape through a similar tube at the other end. The apparatus is set obliquely by putting a couple of blocks (*g*) under two of its legs. This size accommodates two rows of test-tubes between which a thermometer is laid.

This combination of "Pasteurization" and "disconnected heating," which has been outlined (*cf.* pp. 446, 447) first used by

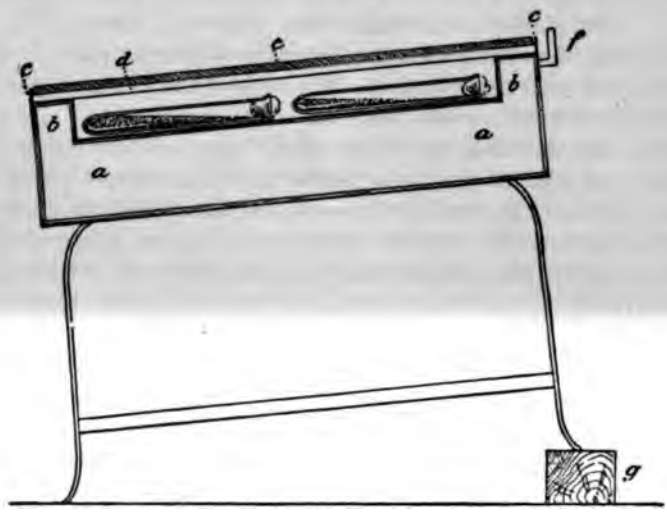

FIG. 16.—Shallow Thermostat for Solidifying Serum Obliquely.

Koch in preparing serum for the cultivation of the tubercle bacillus, must always be used when the blood has not been collected with the greatest possible cleanliness. But when the occasion offers for collecting blood by skilfully bleeding the animal, with sterile instruments, after carefully washing the neck of the horse or cow with 0.1 per cent sublimate, it is usually safe to omit the tedious and difficult preliminary sterilization and immediately proceed to solidify it at 68° to 70° C. after putting it into the test-tubes.

If it is desired to keep serum sterile for some time in a large vessel, the method that has been described cannot be used, but it is best to filter it through a Chamberland filter

(under low pressure) into a Pasteur flask (Fig. 67), the tube of which is then quickly sealed by melting, and is first opened when the fluid is distributed into test-tubes.

Serous accumulations, such as those of ascites, pleuritis, or hydrocele, which can also be used as culture media (*cf.* Chapter XI.), are treated exactly like blood serum.

If 6 to 8 per cent of sterilized glycerin is added to the fluid serum and this is solidified at a slightly higher temperature than that which has been given (75° to 78° C.) solid glycerin serum is obtained, which, according to the observation of Roux and Nocard, is a much better culture medium for the tubercle bacillus than serum alone.

Serum can also be applied as a gelatinizing constituent of culture media, like gelatin or agar. Toeffler has advantageously used a mixture of three parts of sterilized fluid serum and one part of neutralized bouillon, containing one per cent of peptone, one per cent of grape sugar and 0.5 per cent of table salt. The mixture was solidified at 66° C.

4. *Softened White Bread.*—White bread is cut in slices and the soft part is broken from the crust in small pieces, which are laid in a thin layer under filter paper, to dry in the air. When, after a few days, it is dry enough to crumble, it is finely ground in a coffee-mill, and this dry bread powder is kept in a jar covered only with paper. When it is to be used, the desired quantity of the powder is weighed out, and poured into a sterilized flask, plugged with cotton, so that it forms a level layer in the bottom of this (about 8 gm. are used for one of the smallest Erlenmeyer flasks). By the use of a pipette, about two and a half times its weight of sterilized water is slowly poured over it. The bread broth formed in this way is sterilized twice by heating it half an hour in streaming steam, with an interval of a day.

White bread can also be used in slices which, either with or without previous sterilization by dry heat, are moistened with sterile water and then sterilized in the steam cylinder. But by pulverizing it, a more uniform and handy preparation is obtained.

This moistened bread is particularly adapted to the cultivation of moulds, but many different bacteria also thrive upon it. It can be improved and varied by moistening it with bouillon, prune juice, decoction of manure, etc. (Brefeld).

5. *Rice Milk.*—Very recently, Soyka has recommended the following mixture, which he has employed with success for his sealed museum cultures (*cf.* Chapter VI.): Rice meal, 10 gm.; milk, 15 cc.; neutral bouillon, 5 cc., mingled very thoroughly, filled into glass trays by a pipette, and sterilized by discontinuous heating in streaming steam on two successive days, during which it solidifies in the bottom of the tray as a white opaque mass.

6. *Other Culture Media.*—Of these, but three will be named: *a.* According to Soyka, other things being equal, spore formation in bacillus anthracis is hastened considerably by the addition of a certain quantity of sterilized sand to the nutrient bouillon; 2 to 4 cc. of bouillon to 25 gm. of sand gives a suitable degree of moisture to this "artificial soil."[1]

b. Cultivation upon moistened blocks of plaster was first used by Engel for inducing the so-called spore-formation in yeasts. Hansen recommends blocks in the form of truncated cones, 3 cm. high, 4 cm. in diameter at top, and 5 cm. at bottom, which are placed in small glass trays 5 cm. deep, loosely covered by similar inverted trays. Sterilized water is poured into the trays so as to reach to the middle of the block.[2] It is also possible to make these blocks of any desired form. I have, for instance, used successfully small plaster cylinders (moulded in glass tubes), that were placed in ordinary cotton-plugged test-tubes. It is to be observed that a mixture of eight parts of plaster and three parts of water is used in making the blocks. The mould in which they are cast must not be oiled. Before use they are sterilized by dry heat of 115° C., since a higher temperature robs the plaster of too much of its water of crystallization.

c. Eggs are shaken up so as to mix the white and yolk, and the surface disinfected with sublimate solution, after which a small hole is made through the shell at one end, by use of a needle, through which the inoculation needle is introduced, and the hole closed by a little cotton and collodion.

d. Colored nutrient gelatin. Noeggerath prepares the following mixture of concentrated aqueous solutions of aniline dyes, representing approximately the spectral colors: methylene blue, 2 cc.; gentian violet, 4 cc.; methyl green, 1 cc.; chrysoidin, 4 cc.; fuchsin, 5 cc., diluted with 200 cc. water. This is allowed to stand 10 to 14 days. Of the blue-black or

dark gray fluid, 7 to 10 drops are added to each 10 cm. of peptonized gelatin (K. P. G.), which is cooked a couple of times, poured out on white porcelain plates, and infected by scratch-cultures (as in Fig. 29). The bacteria by their growth produce color changes in the gelatin, which can be used for diagnostic purposes.[3]

Filling the Culture Vessels.

So far as serum, bread, and rice-milk are concerned, the process has been already described. Only the gelatinizing media need closer consideration. These are stored, like culture fluids, in cotton-plugged medicine bottles holding 150 to 250 cc. each. It is convenient to have, in addition to these, smaller reservoirs, *e.g.*, large test-tubes, so that when only a little gelatin is needed it will not be necessary to open a large flask, since each time that one is opened, what remains in it must be re-sterilized for safety.

Fig. 17.—Pipette with Cotton Plug at *a*.

When the contents of a storage bottle are to be distributed into culture glasses they are melted in the water bath, or better, the steam cylinder. Test-tubes and other relatively wide-mouthed vessels can be filled by pouring directly from the bottle, or better, by the use of large pipettes (Fig. 17). These are cleansed, dried, wrapped in paper, and sterilized in the usual manner, if their size allows, in the dry oven at 150° C., otherwise they are drawn back and forth for some minutes through a gas or alcohol flame. To avoid contamination of the pipettes when they are laid down, they may be supported on small knife-benches (Fig. 18), such as are frequently used by housekeepers, the upper side of which is cleansed by flaming before they are used. The only other precautions to be taken are, to close the tubes as quickly as possible, and to see that each tube is filled for at least 3 cm. with gelatin, and that the top of the tube is not moistened where it comes in contact with the cotton plug, or the latter will become fastened to the glass. When flasks with a narrow neck are to be filled, this is best done by aid of a common wash-bottle, sterilized by steam.

After filling, the glasses are finally sterilized in the steam cylinder for five or ten minutes. If this apparatus cannot be used, each test-tube or flask is boiled by itself. When the gelatin has solidified, the test-tubes are best kept by wrapping a few together in paper, by which the surface, and especially the cotton, is kept from becoming dusty.

After standing for some time, the gelatin begins to dry out, as is shown by the sinking of its surface at the middle of the tube. When a needle is thrust into such gelatin, it does not close after the needle is withdrawn, but a crack forms, which may materially modify the appearance of the culture when bacteria eventually develop along the puncture. Before

Fig. 18.—Pipette on Knife-rest.

it is used, such gelatin should always be melted and allowed to solidify again.

To prevent the drying out of cultures on gelatin or agar, which is especially rapid when they are kept at an elevated temperature, the cotton-plugged ends of the tubes may be covered with small rubber caps. Care should be taken that both the caps and the cotton plugs are absolutely sterile, or there is danger of the cultures becoming contaminated. Mould spores, especially, which are unable to germinate in the uncapped and therefore dry plugs, germinate readily in the moist cotton, and grow through it. For this reason, it is necessary to singe the top of the plugs, and to carefully disinfect the rubber caps in sublimate immediately before putting them in place. The drying out of culture can also be prevented by singeing the cotton, and then dipping the top of the test-tubes in melted paraffin, which quickly hardens in an air-tight layer.

CHAPTER IV.

PURE MATERIAL FOR CULTURES.

It has been shown in the preceding chapters that it is relatively easy to sterilize apparatus and nutrient media, as well as to keep them sterile for an unlimited time. The only serious difficulty in the cultivation of bacteria has always been connected with another point—the procuring of pure material for starting the cultures. The ubiquity and small size of bacteria have necessitated the application of quite peculiar and complicated methods. Their omnipresence makes it hard to avoid foreign germs, while their minuteness interferes with the sowing of a single germ, as is done in the cultivation of higher plants.

For certain forms of fungi this may be attained. Thus, Brefeld long since (1874) postulated and fulfilled the requirements for his mould cultures, that they should originate from a single spore, planted under microscopic control; and in 1883 Emil Chr. Hansen, in his work on yeast, which is so full of importance for breweries, prepared his cultures, which demonstrably start from one yeast-cell, by the use of other and better methods than those used by Brefeld.

On the other hand, the evanescent, small, and little characterized germs of bacteria cannot, as a rule, be handled in this way. It has been necessary to seize upon other means of getting pure inoculation material for cultures of these, and in 1881 Koch succeeded in a simple and ingenious manner in overcoming the difficulties and indicating a way of isolating bacteria germs, which will surely remain in the future as the chief method.

Before we proceed to a description of Koch's method, which, with various modifications, will be constantly used in the work that follows, we must briefly consider the earlier methods of securing pure cultures, not only because of their

historical interest, but also because under certain circumstances, notwithstanding the discovery of the far more perfect process of Koch, we may be obliged to use them, or may find it advantageous to do so.

All of the methods which have thus far been used for securing pure inoculation material may be arranged in two principal groups: A, those in which use has been made of physiological differences between the bacteria for separating them; and B, those in which the actual separation of the germs from one another is used as the means of isolation.

A. Use of Physiological Differences.

If, for instance, one virulent form exists among a number of non-parasitic forms, in a putrid fluid, it may be obtained in a state of purity by the inoculation of a suitable animal, in the blood of which only the virulent form will come to development while the others die. In this way, from putrid blood, have been obtained the microbes of Pasteur's rabbit-septicæmia, Koch's mouse-septicæmia, and Davaine's rabbit-septicæmia. Or, for another example: according to Pasteur, in the blood of an animal dead of splenic fever, which has been kept at a high temperature, or which, from the size of the animal, has cooled slowly, there is found, so soon as putrefaction has set in, besides the anthrax bacillus, that which he has called the vibrion septique (which is identical with Koch's bacillus œdematis maligni). Pasteur succeeded in isolating these two pathogenic forms by utilizing their different behavior with respect to free oxygen; for as the first is anaerobic while the second is aerobic, and both grow in broth, he obtained a culture of one or the other by sowing the blood in receptacles from which all air was removed and kept out by carbonic acid (*cf.* Chapter VIII.), or in an ordinary culture vessel. These examples might be increased by many more, such as cultures in acid and alkaline media, with or without the addition of certain antiseptics, at higher or lower temperatures, etc.; but only two of the methods of this class will be dwelt upon a little more fully, viz.:

1. *Klebs' Fractional Cultures* (1873).—A fluid in which a large number of different bacteria live and thrive together, will necessarily not contain an equal mixture of all these

forms at every point. Some of the quiescent forms will sink to the bottom or adhere to the sides, while others can move about everywhere in the liquid. Some forms will form superficial pellicles, others thrive only below the surface, where there is less oxygen. Moreover, according to the nature of the fluid, some forms will fill it with great rapidity, and far surpass in numbers others which only manage to lead a restricted existence in the liquid. If a very small quantity of such a fluid containing bacteria is sown in a culture glass, in all probability only a few forms will be transferred, and these, less equally distributed, will develop in unequal numbers. If an extremely small quantity of this new mixture, containing fewer forms, is again transferred to a new culture flask, and this process is repeated several times, in all probability a point will finally be reached where the material used for the transfer is absolutely pure, *i.e.*, includes only a single kind of bacteria.

This method has only slight value, and it is especially to be observed that such fractional cultures are by no means to be counted on as finally giving a pure culture of any specified form among those that were found in the original fluid, not even that form which was most abundant there. The final product is often only one of the most widely distributed of the common putrefactive bacteria, which, even though originally present in small quantity, easily gains the advantage of the others. Still this method of fractional cultures may serve a useful purpose now and then, as supplementary to others.

2. *Cohn's Heating Method* (1876).—It had long been known that various organic fluids (milk, hay-infusion, infusion of peas, etc.), notwithstanding rather long cooking and the exclusion of germs from the air, became the seat of bacterian development, and adherents of the theory of spontaneous generation had repeatedly taken this fact as favoring their doctrine; but it was first shown by Cohn in 1876, in a series of experiments with hay infusion, that this must depend upon the extraordinary resistance of certain bacillus-spores to heat. The boiling heat rapidly destroyed all bacteria without spores, but the latter (in Cohn's experiments those of bacillus subtilis) where not killed—a fact which Brefeld also showed later by direct microscopic observation of the germination of the cooked spores. This afforded a means of obtaining pure material of certain spore-forming bacilli, and, as a rule, a pure

bacillus subtilis can be obtained without difficulty
owing manner: A small quantity of water is poured
hay in a flask, which is kept for hours at 30° to 40°
in the brood-oven, or directly over the flame, while a
thermometer is placed in the fluid). The dark reddish-brown
infusion is diluted with distilled water until it reaches a clear
golden color (s. g. 1.006), when it is filtered through muslin,
neutralized with sodium carbonate, distributed in several ves-
sels plugged with cotton, and cooked for ten minutes, after
which it is set away in the brood-oven at 30° to 40° C. In the
course of a couple of days, a larger or smaller number of the
vessels will contain a growth of bacillus subtilis, which may
n by the fact that it forms a firm rigid film on the
the liquid.
must be remembered that among the various resistant
of bacilli there is a great difference in their ability to
heat of 100° C. Some survive only a very few moments
le others bear this temperature for hours (*cf.*
The limitations of this method are indicated
has been said. It is possible to isolate by it only
which form very resistant spores, and a really
e is obtained with certainty only when the boiled
not contain several different forms with the same
power of resistance. Still there will be exceptional cases in
which there is use for cooking as an aid in isolation.

B. Methods by Separation.

1. *The Capillary-tube Method* (Salomonsen, 1876).—Greater success has been reached by the use of methods in which an actual separation of the original germs is secured. The oldest of these is the following, the starting point for which was an observation of the color changes in putrefying blood. During decomposition, bright red ox blood, defibrinated by whipping, assumes a dark red or red-brown color, which is partly due to the removal of their color from the red corpuscles, partly to deoxidation of the oxyhæmoglobin, and partly to other chemical processes. If the blood, immediately after being defibrinated, is set away in a cylindrical glass where it can remain entirely undisturbed at a comparatively low temperature, *e.g.*, 10° C., it is seen that the change of color begins in spots here and there in the mass of blood. A closer investigation shows

that these putrefactive blotches are due to bacteria (or moulds or yeasts). Next the bottom (Fig. 19), where the crowded blood discs form a solid mass, in which the bacteria grow equally in all directions, the spots are round, clearly defined, and dark red. Above (*b*) they are elongated, often club-shaped, less clearly outlined, and by no means of so dark a color. Here the blood discs are suspended in a relatively large quantity of serum, and in this fluid the bacteria have been able to sink uninterruptedly to the bottom, marking their path by elongated spots or streaks.

FIG. 19. — Cylindrical Glass Containing Whipped Ox Blood showing Purification Blotches. *a*, Serum layer; *b*, elongated discolorations; *c*, round spots and precipitated blood-corpuscles.

If this is to be utilized in obtaining pure material of the various putrefactive bacteria which grow in blood, it is only necessary to draw the defibrinated ox blood into long capillary glass tubes (50 to 60 cm. long and 0.5 to 1 mm. in diameter), and to attach these to strips of card-board about 3.5 cm. wide, by means of a drop of varnish at each end, which at the same time seals them. The following can be recommended as a suitable cement: 8 parts of rosin, melted with 2.5 parts of wax while the mass is constantly agitated. Of 1 part of turpentine, enough is added, little by little, so that a drop of the melted mass quickly solidifies when allowed to fall on a glass plate. Another good cement is the "Cire Galoz" (to be had of Alvergniat Frères, 10 Rue de la Sorbonne, Paris).

They are then laid away at the ordinary temperature of the room, for daily observation. The putrefaction blotches will soon appear; some shortly after the drawing of the blood, others many days later; some spreading with extraordinary rapidity, others growing only slowly. The number of each spot in sequence, the time of its appearance, as well as its growth from day to day, are easily noted upon the card. The growth is best indicated by pencil marks drawn every morning and night after the fashion shown in Fig. 20. This illustration, which shows one end of a card to which is cemented a capillary tube containing three putrefactive spots, renders further description unnecessary.

These putrefaction spots come from the bacterian germs which have chanced to get in the blood after its removal from the animal, so that in one lot there may be many of them, in another few; but each spot contains only a single sort of bacteria, developed from one germ. Consequently, when the discolorations are relatively far apart in the tubes so that they do not readily become confluent, each of them gives a small pure culture, from which pure material may be obtained of a specific form of bacteria. By this method, a mixed putrefaction-flora was first separated into its elements, so that the number of germs, the time of their development, rapidity of growth, etc., could be graphically represented.

2. *By Dilution* (Lister, 1878, Naegeli, 1879).—This method consists in diluting a fluid containing bacteria with sterile

FIG. 20.—One end of a Pasteboard Bearing a Capillary Tube Filled with Blood. On the card are noted the time (10 A.—afternoon of 10th day; 9 M.—morning of the 9th day), when the spots appeared, the rapidity of their growth (indicated by the length of the lines), and their number in series (*I.*, *II.*, *V.*)

water to such a degree that a given quantity of the mixture holds only one germ, and in using such an initial quantity for inoculation. In the culture-flask, the offspring of this single germ forms a pure culture.

Counting the germs in the original fluid is effected under the microscope, by the aid of instruments similar to those used for counting blood-discs. From this the number of germs in, for example, 0.05 cc. of the fluid, is estimated, and by aid of a sterilized graduated pipette, this quantity is added to enough sterile water so that the mixture, after careful shaking, must average half a germ for each 0.05 cc. When by means of a sterilized graduated pipette, this mixture is inoculated into a series of culture-vessels, so that 0.05 cc., is placed in each, half of the glasses will not show any development of bacteria, having received no germs, while in all probability but one germ will have been placed in each of the others, which will then contain a pure culture. Lister devised and

used this method for obtaining pure cultures of lactic acid bacilli. Naegeli, independently, cultivated micrococcus ureæ by aid of the method of dilution.

3. *By the Use of Solid (Especially Gelatinized) Media* (Koch, 1881).—This method consists in the isolation of the germs upon or in solid culture-media, where, in their later development, they give rise to separated colonies. If, in a flask like that shown in Fig. 9, VII., the bottom is covered with a thin layer of nutrient gelatin, and, after melting this at about 30° C., a very small drop of fluid containing bacteria is added and thoroughly distributed through the gelatin by careful shaking (*cf.* Chapter VII.), and after solidifying, the mixture is set aside at room temperature, after a time small colonies will appear at the surface of the gelatin. Each comes from one germ, so that pure material for inoculation is obtained.

This is but one of the many forms in which the method of Koch may be used. In a subsequent chapter, dealing with bacteriological analysis, the method will be treated particularly and in detail.

By aid of these methods, pure inoculation material can comparatively easily be obtained of all aerobic bacteria (*cf.* Chapter VIII.) which it is chiefly necessary to cultivate. It remains only to consider the best way of transferring this to the culture apparatus.

CHAPTER V.

INOCULATING CULTURES.

THE transfer of pure material to one of the culture vessels that have been described, is comparatively easy. The necessary opening of the different vessels, and the transportation of the inoculation material through the air necessarily entails danger of contamination. But this danger is very small, and if the work is done rapidly and carefully, the transfer is unsuccessful in a very insignificant number of cases.

The instruments needed are: 1, Platinum needles (Koch), long capillary tubes of glass, Pasteur pipettes, and glass needles.

1. *The platinum needle* consists of a glass rod about 27 cm. long and 4 or 5 mm. thick, in one end of which a piece of platinum wire about 3 cm. long is melted as shown in Fig. 21. Just before use, the surface of the glass rod is flamed, and the platinum wire brought to redness throughout its entire length. When, after a few seconds, it has cooled sufficiently, this is brought in contact with the material to be transferred, and quickly brought into the culture medium.

It is usual to have at hand some quite thin needles, and some which are a little thicker. An advantage of the former is that they cool quickly, while the latter are less flexible and can for this reason be used when the needle is to be thrust into more resistant substances, *e.g.*, liver or lung (or when it is necessary to apply considerable lateral pressure, as in distributing a colony of the tubercle bacillus over agar, etc.).

For certain cases, the platinum wire may be specially shaped. Small loops (Fig. 21, *b*) insure the adhesion of larger quantities of the inoculation material. A large loop (*c*), catches a good-sized drop. It is bent at a right angle (*d*), when one wishes to scratch the material into the surface of the gelatin (*cf.* what is said elsewhere about cultures on potato, slides, etc.).

When the inoculation must occur through a relatively small opening, through which the glass rod can be passed with difficulty or not at all, a sufficiently long piece of platinum wire can be used, or small pieces (5 or 6 mm. long) are employed by seizing them with sterilized forceps, glowing them, bringing them in contact with the inoculation material, and dropping them through the small opening into the culture flask. Capillary tubes and glass needles can, of course, also be used in such cases.

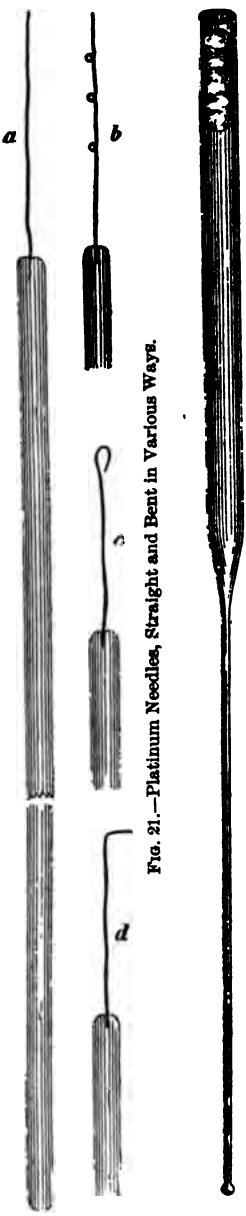

Fig. 21.—Platinum Needles, Straight and Bent in Various Ways.

Fig. 22.—A Pasteur Pipette.

2. *Capillary tubes* usually have a length of 20–25 cm. and are closed by melting at both ends. Before being used, one end is broken off, the surface is flamed, and the open end dipped into the fluid to be sown, when the other end is broken, upon which the fluid rises into the tube. The contents are blown out into the culture-vessel to be used; care being taken not to blow all out, but to leave a little fluid in the tube, thus preventing contamination from the air blown in.

3. *Pasteur pipettes* consist, as is shown in Fig. 22, of a piece of glass tubing, one end of which is closed by a cotton plug, which must not project beyond the glass, while the other end is drawn out into a capillary tube fused at the end. The plugged tubes are sterilized at 150° C. Before being used, the sealed end of the tube is broken off, and this part of the glass is flamed. The tube is filled by suction, and emptied by blowing the fluid out. These pipettes have the advantage over capillary tubes of being more capacious, and they

can be used as culture-glasses by reclosing the capillary extremity by heat immediately after filling. See also Chapter XI.

4. *Glass needles, i.e.,* glass rods drawn out into a very slender thread at one end for about 15 cm., are better than platinum needles in their perfect smoothness and rigidity, which may occasionally be of importance, as in making thrust-cultures of anaerobic forms, where it is wished to avoid introducing small air-bubbles into the gelatin.

One can easily make these inoculation instruments for himself by using an ordinary Bunsen burner or a good spirit lamp. A glass-blower's outfit naturally lessens the work, but it is not necessary.

For platinum needles, a glass rod about 4 mm. in diameter is divided into pieces 25 or 30 cm. long, by slightly marking it at the proper points with a triangular file, when by steadily pulling the glass in opposite directions at each side of the scratch, with a slight side motion, it is easily and evenly broken at the desired spot. The end of a piece into which the needle is to be fastened is rotated in the flame with the left hand, until it becomes red and soft, while a piece of wire of the right length, grasped some 5 mm. from one end in a pair of forceps, is brought to a white heat at this end and carefully thrust lengthwise into the softened glass, which is then allowed to cool gradually, being held for a few seconds close to the flame. The other end of the glass is finally rounded off by heating it to redness, rotating it meantime.

A glass tube 6 or 8 mm. in diameter is easily drawn into capillary tubes in the following manner: The tube is heated to redness for a short distance (1–2 cm.), while being rapidly revolved about its axis, until it becomes thoroughly softened, when it is removed from the flame and drawn into a tube about six feet long, which is melted off from the thicker glass at each end. In the same way, by aid of the flame, the long capillary tube is divided into pieces of the length indicated above, which are at the same time hermetically sealed at the ends. The strong heating of the glass, and the sealing of the tube which immediately follows, insure freedom from germs. The larger the original tube the greater the length for which it is melted, and the slower it is drawn out or the shorter the length of the capillary tube the coarser this will be, and con-

versely. This being borne in mind, it is easy to experiment until a tube of the diameter wished in a given case is obtained.

Pasteur pipettes are made by dividing a glass tube into pieces 15 cm. long, by aid of a file. Each piece is then heated in the middle while being revolved, and drawn out in the manner already described into a capillary portion about 30 cm. long, which is then melted and sealed at the middle, making two pipettes. The sharp edges of the other ends are rounded off by briefly glowing in the flame. After they are cooled, they are plugged with cotton, and finally sterilized at 150° C.

Glass needles are drawn out in the same way, solid rods being used instead of tubing.

To indicate the many little manipulations necessary in making a pure transfer, a detailed account is here given of (*a*) the inoculation of gelatin in a test-tube by use of the needle, and (*b*) the inoculation of fluid in a narrow-necked flask, by the use of small pieces of wire.

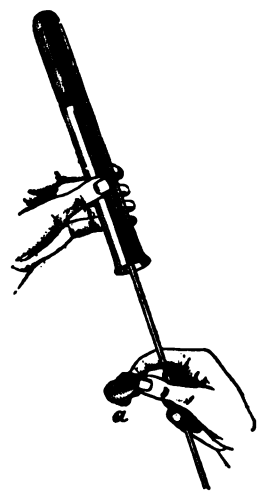

FIG. 23.—Inoculating a Test-tube of Gelatin.

a. Several tubes of gelatin that has not dried out too much (*cf.* p. 474) are chosen, and the cotton plugs are tested by twisting them several times to be sure that they are not glued fast to the glass. The needle is sterilized as indicated above. After allowing it to cool for a couple of minutes, the tube from which the transfer is to be made is opened by removing the plug by a twisting motion which causes any fibres that may have adhered to the glass to lie out of the way of the needle. The tube is held with the top upward, or inverted, according as the bacteria growing in it have liquefied the gelatin or not. The removed plug is held so that the part of it which comes in contact with the inner face of the glass shall not touch anything by which it might be contaminated. The needle is now quickly plunged into the culture, removed, and the plug replaced. (As a rule only the tip of the needle is brought in contact with the culture, a sufficient number of germs will always adhere to it. If for any reason a large quantity is to be transferred, loops such as are

shown in Fig. 22, *b c* are used.) The tube to be inoculated, held in an inverted position (Fig. 23), is now quickly opened with the same twisting motion, the needle is rapidly thrust into the gelatin at one or more points, the plug replaced, and the needle at once sterilized by glowing. A label containing record of date, source of material used, etc., is then pasted upon the tube.

b. The surface of the flask is carefully dried, after which the lower part of the rubber tube and the contiguous part of the neck are flamed by use of a burner or alcohol lamp, and the rubber is slipped up a little, so that it can easily be removed by one hand. Sterilized forceps are placed upon glass benches (Fig. 18) or in a shallow glass. Small pieces of platinum wire are kept ready in a glass tray. One of these is grasped by one end with the forceps, at right angles to its axis. The wire is brought to a red heat, allowed to cool, and plunged into the colony of bacteria, etc., from which the transfer is to be made. With the left hand, the flask is now quickly opened, the wire dropped into the narrow opening, the cap firmly replaced, and a label prepared.

CHAPTER VI.

BROOD-OVENS AND THERMO-REGULATORS.

A MAJORITY of the bacteria known and cultivated up to the present time thrive at the ordinary temperature of a room (15° to 20° C.). Consequently if it is only desired to keep cultures going and to observe their growth, it usually suffices to set them aside in a living room. For preserving cultures for a long time, especially as museum specimens, Soyka recommends inoculating solid media in the small glass boxes shown in Figure 11, which are then carefully sealed with paraffin. By this means he succeeds in checking the growth of the colony at a certain point of its development, while the capability of germination is preserved, and drying out is hindered. For details see "Zeitschr. f. Hygiene," 1888. After a shorter or longer incubation period, they will be seen to start into growth, and even by the naked eye it is possible to observe the great dissimilarity which often exists between cultures of different bacteria. Even in 1880, when fluid cultures were almost exclusively used, I noticed in detail the microscopic differences that cultures often present, and called attention to their indications in judging of the purity of a culture, and the diagnosis of bacteria, which was sometimes more easily made by the naked eye than microscopically. When, later, Koch's gelatin cultures came into use, still more occasion was offered for the observation of evident microscopic differences between cultures of bacteria, such, for instance, as are shown in Figures 42 and 69. Sometimes it is very necessary to cultivate bacteria at a higher and more uniform temperature than that usual in our living rooms, for some forms develop quickly only at higher temperatures, others never thrive below 30° C., and some species demand heat for the production of spores. Moreover, indeed, as Pasteur first showed, cultivation at a high temperature may change the physiolog-

ical character of bacteria, and is used in the fabrication of "vaccines." It may also be frequently desirable to cultivate a micro-organism for a long time at a constant temperature, whatever this may be.

Hence are used thermostats or brood-ovens, in which the temperature is held unchanged for weeks or months at the same

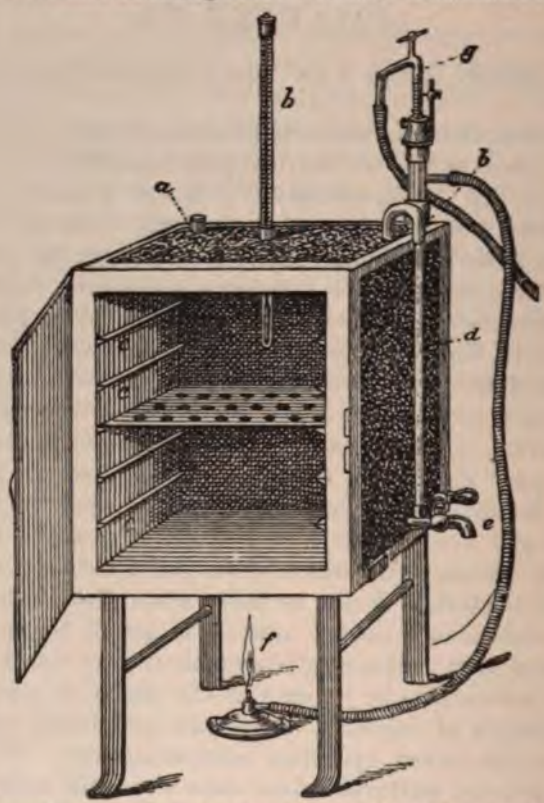

FIG. 24.—Brood-oven Covered with Felt, and Controlled by a Thermo-regulator.

point. The maintenance of a constant temperature is beset with certain difficulties. The changes in temperature of the room in which the thermostat stands is disturbing; to counteract them the brood-oven is inclosed in as thick a layer of some non-conducting material as possible, and set up in a cellar or similar place, where the temperature changes but little. Variations in the strength of the source of heat used also act in the same way, as is especially evident when gas is used,

since the gas pressure may vary much in the course of the day. This may be obviated by the use of pressure-regulators and thermo-regulators of various construction.

A serviceable small thermostat, comparatively cheap, and self-regulating, is shown in Figure 24. It is a quadrangular box of zinc or copper, set upon a strap-iron support with legs about 24 cm. high. The top and bottom, as well as three of the side walls are double, and the space between them, which is 2 to 2.5 cm. wide, can be entirely filled with water through the opening (*a*), which is afterward closed by a cork. The fourth side is single, and serves as a door. In the centre of the top, an open tube 3 cm. in diameter is fastened into the wall, piercing it. Into this by aid of a perforated cork, a thermometer (*b*) is set, which projecting into the interior of the box, can be examined without the necessity of opening the thermostat. Usually a thermometer is also kept entirely in the thermostat, standing in a vessel filled with oil, which prevents the mercury from sinking too rapidly when the glass is removed to observe the temperature. On the inner face of the two side walls are fastened a number of small ledges (*cc*) on which glass or tin shelves may be laid to provide support for a large number of low objects. The outside of the box is covered with felt, and provided with a glass tube for showing the height of the water (*d*), and a faucet (*e*). It is heated by a Bunsen burner, the tube of which has been removed, so that it gives a pointed white flame, which permits the flame to be reduced to a minimum with no danger that it will "snap back." [If the brood-oven is to be kept but little above the room temperature, there is some danger that the flame may occasionally go out, allowing the escape of a large quantity of gas into the room before it is discovered. For this reason, the safety burner devised by Koch, and to be had of dealers in bacteriological apparatus, though somewhat expensive, is to be strongly recommended, since it promptly and automatically cuts off the supply of gas in case such an accident occurs.—W. T.] The temperature is held at a constant point by the use of the regulator (*g*), which is passed into the water-filled space through an opening at *b*. Two generally used and good types of thermo-regulator are shown in Figures 25 and 26. Rohrbeck's (Fig. 25) is especially to be recommended.

Reichert's latest regulator is shown in Figure 26. The gas

enters at *a*, passes through the opening *b*, and out toward the burner at *c*. The column of mercury is adjustable by the screw *d*. In case this should rise so as to entirely close the opening *b*, the flame is not extinguished, for a minute opening is provided in the T-shaped tube at *e*, which permits the passage of just enough gas to keep the flame alive, without heating the thermostat appreciably. The right size of this pin-

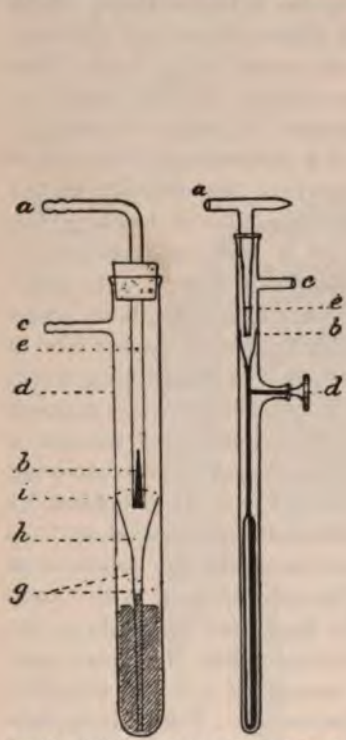

FIG. 25.—Rohrbeck's Thermo-regulater.

FIG. 26.—Reichert's Thermo-regulator.

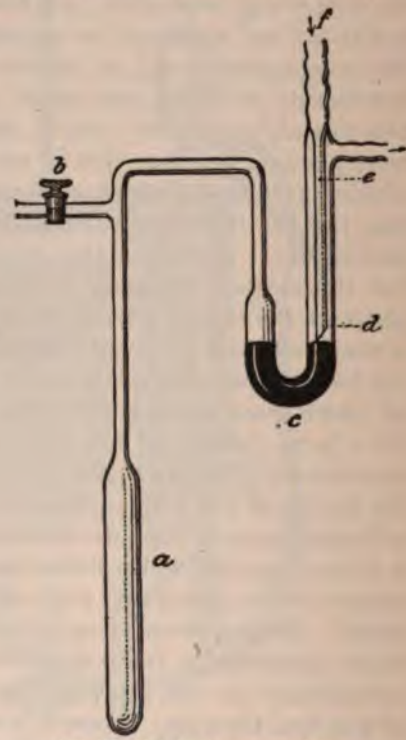

FIG. 27.—Bohr's Thermo-regulator.

hole is reached when the gas passing through it burns with a perfectly blue flame.

Rohrbeck's modification of the Lothar-Meyer regulator, is shown in Fig. 25. It is much more sensitive than the Reichert instrument, since it is regulated by mercury and ether, the vapor of which changes in tension comparatively strongly with slight changes of temperature. The gas enters at *a*, traverses the tube *d*, in which at the bottom an acute, sharp-

angled triangular opening (*b*) is made, and passes out toward the burner at *c*. The mercury is indicated by line-shading, vapor of ether fills the chamber *g* [which is limited by a glass diaphragm *hi*, prolonged downward into a tube open at the bottom, which plunges well into the mercury]. When the apparatus is warmed, the mercury is forced by the expanding ether-vapor into the tube *hh*, say to the dotted line *i*, so as to partly close the triangular opening, which is then enlarged or diminished according as the mercury falls or rises. From the form of the opening, and its sharp angles, this adjustment occurs very uniformly. The first adjustment of the apparatus is effected by sliding the tube *d* up or down through the bored cork by which it is adapted to the larger tube. Fig. 25 show the regulator in its cheapest form. There is also a more improved form, in which the tube *d* is of steel, and adjustable by a fine screw (Fig. 24, *g*).

A regulator constructed by Bohr (Fig. 27), offers considerable advantages as compared with these commonly used models. The reservoir *a*, filled with air, is brought, with its stopcock *b* open, into the chamber that is to be kept under control. Shortly before the desired temperature is reached, the cock *b* is closed, after which every rise of temperature, however small, will cause an expansion of the air in *a* and a displacement of the column of mercury, which closes the opening *d*, allowing the gas to pass only through the reserve opening *e*. It must be seen that the inside of the reservoir *a* is not damp when the apparatus is put in use. Enough mercury is poured in through *f* to reach as high as *d*, so that this opening is entirely closed by a slight displacement of the mercury. It is advantageous to have the U-shaped tube constricted at *c*.

In addition to its great simplicity, the Bohr regulator is superior to those previously described in that the same instrument can be used at any desired temperature below the melting-point of the glass, and is adjusted for any temperature with extreme ease. It is also equally sensitive for all temperatures. The influence that considerable barometric changes exert on it (as well as on the Rohrbeck model) is readily compensated by opening the cock (*b*) for a moment. It further deserves mention, that by Bohr's regulator a constant mean temperature can be maintained in larger spaces, since the reservoir *a* may be given any desired form and size;

or a long lead tube with one end hermetically sealed (pinched or melted together) may be used as a reservoir, passing into various parts of the chamber.

A thermostat of this construction, with regulator, will generally be sufficient even for finer experiments, which demand a constant temperature during months. In most cases, however, we need only to have a chamber in which bacteria can be grown at something above 30° C., and for this a thermostat is perfectly good and useful, even if it varies a few degrees in the course of the day. If too much is not required, the regulator may be entirely dispensed with, and an ordinary gas, petroleum, spirit, or oil flame used. Of these four sources of heat, the first and last are unconditionally to be recommended. In case the apparatus is to be kept in our working room, petroleum is less satisfactory because of its ill-odor, independently of the greater danger from fire. Alcohol is better than [lard]-oil only in giving a flame free from smoke, while oil is cheaper and requires less care in its use.

It is naturally most convenient to use gas when this is at hand in the room. Since the gas flame as a rule needs to be only small, when a small thermostat standing in an inhabited room is to be kept at 30° to 40° C., a pointed yellow flame is always to be used (*cf.* p. 489). By a few days' experimenting, the proper height of the flame is ascertained, and when the temperature of the surrounding air does not vary too much this affords a good guide. A regular periodical change in the gas pressure, as at night, is easily compensated for by slightly raising or lowering the burner each day at the necessary time.

If one is unable or unwilling to use gas, [lard]-oil is to be recommended, especially if used as shown in Fig. 28. A large basin is filled to within a couple of centimetres of the top with water (*d*). Over this is poured carefully a layer of oil 2 cm. deep (*c*), upon which are placed one or several small floats (*f*) with wicks, such as are used on the continent for night-lamps. Such a floating burner gives an especially constant heat. As the flame cannot be changed in size, it is necessary to find the right distance between it and the thermostat; and since this must be kept as nearly constant as possible throughout the day, it is usual to employ a large bowl and a thin layer of oil, so that the wick shall not recede too far from the bottom

of the brood-oven as the oil is used up. The small wicks are renewed morning and evening.

In Figure 28 is shown a still cheaper thermostat than that represented in Fig. 24. It has no regulator, no tube for showing the height of water, no faucet for removing this, and no attached covering of felt. But it can at any time be easily

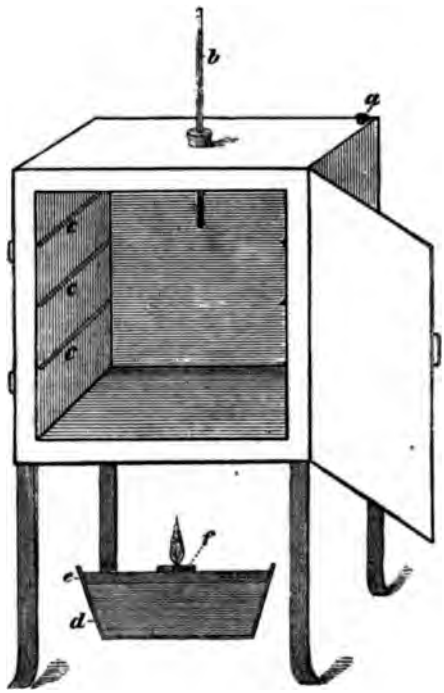

FIG. 28.—Simple Brood-oven Heated by an Oil-lamp

covered by rectangular pieces of felt or flat sheets of cotton-batting, of which four can be sewed together at their edges, while the fifth, over the door, is fastened only by its top to the upper piece, so that it can be lifted when the door is to be opened, while it is tied to the side pieces when the door is closed.

CHAPTER VII.

BACTERIOLOGICAL ANALYSIS OF FLUID, SOLID, AND GASEOUS SUBSTANCES; ESPECIALLY OF WATER, THE SOIL, AND AIR.

MICROSCOPIC investigation shows very incompletely what living germs are present in a preparation. Different appearing micro-organisms may represent different stages in the development of a single species, and bacteria which look quite identical may belong to entirely different species. Moreover, all germs of bacteria are by no means recognizable as such under the microscope; and the living are not certainly distinguishable from the dead. If the question is merely whether some specified virulent form occurs in a sample of earth or water, in case this form is pathogenic for animals, the most direct answer will be obtained by inoculation. Water is subcutaneously injected into a suitable animal. Earth is placed in a little pocket made in the subcutaneous tissue. Bacteria from the air are first collected in a sterilized filter of sand (*cf.* analysis of air), which is then introduced into such a pocket. But a satisfactory bacteriological analysis cannot to-day be made without recourse to cultures. It is of especial interest for the physician to know these methods, since they afford the most important introduction to hygienic investigation of water, earth, and air. Since the discovery of the cholera *spirillum* they have also been included among the best methods of clinical investigation. An exhaustive bacteriological investigation includes a determination of the number of bacteria present, as well as their identification; but for easily understood reasons, in both hygienic and clinical investigations, qualitative analysis is most frequently of entirely greater importance than quantitative.

A. Liquids.

(With especial reference to water analysis.)

All of the methods indicated in Chapter IV. may find application in the bacteriological analysis of fluids. Of these, we usually resort to dilution, and isolating the germs in nutrient gelatin, as the two principal methods.

The latter, first indicated by Koch, and developed by him to a high degree of completeness, is alone sufficient in by far the greater number of cases, and consequently will be treated here in detail. Koch's method consists in mingling the fluid containing germs with liquefied gelatin, which is then spread in a thin layer and allowed to solidify, being protected from atmospheric contamination. The mixing and spreading can obviously be effected in a great variety of receptacles, among which are four deserving especial attention.

a. Conical Flasks.—A medium-sized flask (Fig. 9, VII.) containing a thin layer of gelatin in the bottom is warmed just enough to melt the gelatin (over-heating may destroy the bacterian germs). By aid of a needle or pipette, a small quantity of the liquid to be analyzed is then added, with the greatest possible rapidity and care. The two are carefully mingled, but without shaking, which might cause the formation of bubbles. To avoid this, the flask is held upright, and several times carried around a large circle in a horizontal plane. The fluid is set in so active movement by centrifugal force that the commingling is perfect, without the introduction of bubbles into the gelatin, which is then allowed to solidify. This is one of the simplest and surest methods by which a Koch isolation-culture can be made. One disadvantage attends it, viz.: the isolated colonies are not accessible, in the flask, for microscopic investigation, and less accessible for examination by the naked eye or with a lens than in the following cases.

b. Test-tubes.—The mixture can also be effected in a test-tube, on the inside of which the gelatin is then allowed to harden in a thin layer (von Esmarch). For such "roll-cultures," wide tubes are best, with about 10 cc. of nutrient gelatin. Naturally, one may add the fluid as indicated in Chap-

ter V., and subsequently melt the gelatin over a water bath, or this may be done first. The mingling of the two is effected as in *a*. The distribution of the gelatin over the wall of the tube is secured simultaneously with its hardening in the following manner: The projecting portion of the cotton plug is clipped or singed off, and the whole covered with a tight-fitting rubber cap to keep the cotton dry, and the tube laid in a dish of cold water, preferably ice-water. While the tube floats on the water, it is kept with one hand as nearly horizontal as possible, while with the other it is rotated until the gelatin has become solid in a uniform layer over the entire inside of the tube, which is then dried off and the rubber cap removed. Occasionally the cotton plug becomes covered with so thick a layer of gelatin as to prevent the access of air to the culture in an injurious manner. In this case, cotton and gelatin may both be pierced by a sterile platinum needle. The advantage of the test-tube over a flask is that it takes up less room, and its contents are somewhat more readily accessible for investigation.

c. Glass Trays.—It is convenient to use a pair of shallow trays (Fig. 12) about 20 cm. in diameter and 1.5 cm. deep, which are, of course, first to be sterilized, well wrapped in paper, from which they are removed only immediately before being used. Mingling the fluid which contains bacteria and the gelatin, is effected in a test-tube as in the last case. The cotton plug is removed and the mouth of the tube flamed [it is better to clip the cotton off close to the edge of the tube, push the plug down a little way, and then flame until the cotton browns a little. After cooling, the plug is easily removed with sterile forceps, and the gelatin poured.—W. T.], and as soon as it has cooled the contents are poured as rapidly as possible into the lower (smaller) tray, while the other, serving as a cover, is pushed a little to one side. Since the tube is never entirely emptied, but a small quantity of gelatin remains in it, it is best to label and preserve it as complementary to the tray culture.

A uniform layer of gelatin is seldom secured in these trays. The bottom is not plane, but as a rule a little elevated in the middle. But the consequent difference in thickness of different parts of the gelatin has its advantage, for when many germs are present in the fluid to be analyzed, and they are

too closely crowded in the thick peripheral part of the layer, they are more isolated in the central thin portion.

The colonies in such tray-cultures are much more easily accessible for examination with the naked eye or lens than in *a* or *b*. Examination is frequently rendered somewhat difficult because the under side of the cover becomes clouded. In this case it may be replaced by a dry and sterile glass plate during the necessary inspection. [Non-liquefying species are readily examined by inverting the trays.] These cultures are also far better for microscopic examination than those in flasks or test-tubes, especially if smaller trays (5 or 6 cm. in diameter) are employed; but they are far from being as good in this respect as plate-cultures.

d. Glass Plates.—This method, the "plate method" of Koch, of which the three preceding are only modifications, dis-

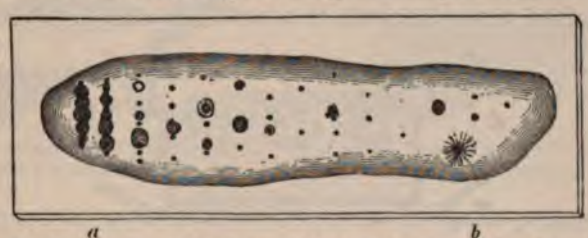

FIG. 29.—Slide Coated with Gelatin Crossed by Fourteen Inoculation Scratches bearing many Colonies. At *b*, a mould colony due to accidental contamination from the air.

tinguishes itself from these not only by a certain elegance, but especially in allowing a microscopic examination of the colonies anywhere on the gelatin, with high magnification. Koch's first plate-cultures were undertaken in the following manner: The gelatin was spread in an elongated drop on a common microscope slide, by the use of a pipette. When it had become solid, it was inoculated by a bent platinum needle (Fig. 21, *d*) dipped in the fluid containing germs, and then used to make a series of transverse scratches on the gelatin (Fig. 29). In the course of a few days colonies of the bacteria appear in the inoculation furrows,—closest and often entirely coalescent in those made first (*a*), fewer and well separated in the last. Assistance in recognizing contamination of such scratch-cultures from the air, is afforded by the fact that they almost always appear between the scratches, as is the case with the mould colony *b*, in Fig. 29. In two respects the

plate method is inferior to the three preceding. From the nature of the inoculation, the plates are more exposed to atmospheric germs; and the distribution of the gelatin over the plates takes more time and care, since it must be kept from running over the edges, which is best avoided by the use of suitable cooling appliances which cause more rapid solidification.

The apparatus needed, and the method of starting a plate culture are, in detail, the following:

Rectangular glass plates 6.5 x 12 cm. are washed, polished with chamois skin and sterilized at 150° C., well wrapped in paper from which they are first removed immediately before use. [For convenience, the sheet-iron boxes used by the Germans to hold sterilized plates, are to be recommended.—W. T.]

The fluid containing bacteria is mingled with the gelatin as explained above (p. 495), in a cotton-plugged test-tube con-

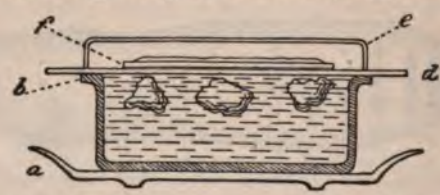

FIG. 30.—A Simple Cooling Apparatus for Plate-cultures.

taining about 5 cc. of peptonized gelatin, a quantity adapted to the size of plate recommended; especial care being taken to warm the gelatin only a little above the melting point.

A serviceable cooling apparatus is easily made as shown in Fig. 30. On an ordinary pie-plate (*a*) is set a preparation glass (*b*) with ground rim, several pieces of ice are placed in this and water is carefully poured in until the vessel is full, with a slightly convex surface, but not running over. A well-cleaned square plate of glass (*d*) is now let down on the surface of the water so as to wet it everywhere and thus avoid air-bubbles, a little water running over into the plate as this is done. Finally, a sterilized glass dish (*e*) is inverted on the plate to serve as a bell-glass.

One of the glass plates is unpacked and quickly laid under the bell-glass (Fig. 30, *f*), where it is rapidly cooled by the ice water. The plug is removed from the infected tube, the margin of which is quickly flamed [here, as above, p. 486, it is

preferable to flame the tube before removing the cotton plug. —W. T.], after which the bell-glass is raised and the still fluid gelatin carefully poured over the glass plate, care being taken not to let it flow too near the margin. The bell-glass is replaced to protect the plate while the gelatin solidifies. The more exactly horizontal the plate stands, the better. If the gelatin runs in a given direction, because the plate is not level, it is possible to carefully lift the apparatus with both hands and check this by adjusting its position, until the gelatin is sufficiently hardened. It is naturally more convenient to level the plate beforehand by using a tripod and level (Fig. 31). If it solidifies too quickly, before spreading over a sufficiently large part of the glass, it may be spread by use of a sterile glass rod, warmed, but not too hot. The test-tube, in which

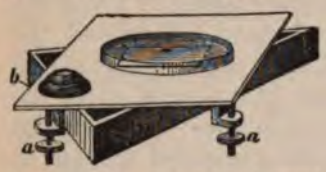

FIG. 31.—Leveling Tripod with Round Level (*b*) and Plate.

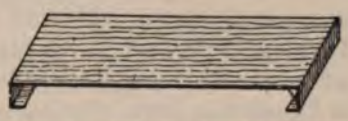

FIG. 32.—Bench of Sheet Zinc for Supporting a Plate-culture.

a few drops of gelatin always remain, is again plugged with the original cotton; labelled, rotated for several minutes and laid horizontally, so that this vestige solidifies in a thin layer, and kept as supplementary to the plate-culture, which, as soon as it has hardened, is labelled and quickly removed to the moist chamber.

For a single plate, a pair of shallow glass trays (Fig. 12) may be used as a moist chamber. But as a rule it is necessary to make several plate-cultures of the same fluid. In this case a pair of larger deep trays are used, or a chamber may be improvised. Before use, it is to be rinsed with 0.1 per cent sublimate solution, and a couple of sheets of filter paper, well wet with the same solution, are laid in the bottom. The plates are set in such a moist chamber, on small glass or metal benches which can be set over one another. Sheet-zinc benches of the form shown in Fig. 32 are very suitable because of their durability. They can easily be sterilized at 150° C. before use.

The examination of the plates by the naked eye is usually

made over either a white or black background (sheets of paper or tiles), as many differences in color between the colonies are only seen well in this way. It is also to be remembered that colonies of the same species and of equal age may present great differences in size, form, and color, according as they grow at the surface or immersed in the gelatin. Counting the colonies is best effected by the use of a lens of low power, and is much easier if the plate is laid on another divided into square centimetres. [When it can be afforded, one of the simple counting appliances used by the Germans in water-analysis, is to be strongly recommended.—W. T.]

The microscopic examination of the plate is not difficult, even with rather high powers. To be able to examine every part of the plate, a smaller size than the one recommended may be necessary, if the stage of the microscope is not quite large. Since it is impossible to calculate beforehand the number of germs added to the gelatin, in each case it is customary to prepare three plate-cultures at a time of three degrees of dilution. This is best done as follows: The gelatin is liquefied in three test-tubes, which are numbered 1, 2, and 3. After 1 has been infected by use of needle or pipette, and the added material well distributed, 2 is infected from it; and, in the same way, 3 from this. The gelatin is poured on the plates as above. In this way, it is highly probable that one of the three plates will contain a suitable number of colonies, whether these are wanted so numerous that the culture can be used for a tolerably reliable estimate of the number of germs present in the fluid (*cf.* water analysis, p. 503), or so few that a nearly absolute guarantee is given of the purity of each colony, and transfers may be made from them without difficulty.

It should be remembered, as advised above, to save the three test-tubes after distributing the gelatin in a thin layer by rolling them several times. Where the object is to get an exact determination of the number of germs in the original fluid, it is necessary to include those remaining in the tube, and, independently of this, it is always an advantage to have two isolation-cultures of each dilution.

Soyka obtains a large number of very small plate cultures by using pairs of trays which differ from those shown in Fig. 12 in being made of glass 1.5 mm. thick, with a bottom 50

square cm. in area, and walls only 3 to 5 mm. Seven round hollows are ground in the lower tray, like those in hollow-ground slides (Fig. 57). Before being used, they are slightly warmed, gelatin is placed in each of these depressions by using a pipette, one of the drops is quickly inoculated with a looped platinum needle, carefully stirred, and a transfer made from this to the second, etc., the upper tray or lid being put in place after all are inoculated. If the pipette is accurately graduated, and the quantity of fluid carried by the platinum loop previously determined by weighing it dry and again with its drop of water, it is claimed by Soyka that a sufficiently reliable determination may be made of the number of germs. This modification of the customary Koch method of plating out cultures appears to me excellent in its plan, but the form of the trays and the limited size of the hollows do not seem so good. For microscopic examination, I would recommend rectangular glass trays (*e. g.*, 12 x 5 cm.), the lower one divided by elevated ridges into eight quadrangular spaces, so that the surface of the several cultures should be larger.

In the preceding descriptions we have always assumed that the isolation was to be effected in either gelatin or agar.

1. *Gelatin.*—This is most easily used, since it may be melted and kept fluid at a relatively low temperature; yet the fact that many bacteria and moulds liquefy (peptonize) the gelatin is a disadvantage that often becomes very evident in such analyses.

2. *Agar-Agar.*—Most bacteria cause no liquefaction of this substance, which is nevertheless not so good as gelatin for plate-cultures, because of the difficulty of melting it and its somewhat slighter transparency, and its tendency not to adhere to the glass; still, it may be used well for analyses of this character if the following precautions are taken. When the agar has been melted in the test-tubes, which does not occur below 90° C., these are set aside to cool for a few moments and, before their contents begin to solidify, placed in a water-bath kept at 40° C., at which point the agar remains fluid, while the liquid containing bacteria can safely be added, without danger of killing any of the germs.

While it is usually necessary when gelatin is used to hasten its solidification by cold (or iced) water, this must commonly be retarded when agar is employed, by placing the plates

over, or rolling the tubes in, lukewarm water, to prevent the agar from forming lumps and as a result hardening with an uneven surface. Since agar adheres so poorly to glass that it occasionally entirely separates from the plate and slips off, Fraenkel advises the use of a drop of sealing wax on each corner of the plate. [Where agar must be used in plating out bacteria, it is much better to do this in trays (supra, *c*), by which the curling of the agar is avoided.—W. T.]

3. *Agar-Gelatin*, prepared after Jensen's formula (supra, pp. 464, 465) combines some of the good qualities of both gelatin and agar. It is very conveniently used for plate-cultures, and, as a rule, is to be recommended in preference to either. The surest way of keeping it fluid during the process of inoculation, is to set the test-tubes in a water bath at 30° to 40° C.

4. *Serum* cannot be used in this manner, since it is coagulated only by prolonged heating to a degree likely to prove fatal to the germs. If it must be employed, one of two methods must be adopted: Scratch-cultures may be successively made with an infected bent platinum needle, in a large number of test-tubes, the colonies being so few in the last of the series as to be separate (*cf.* the original scratch-cultures on slides, p. 497); or the fluid to be used may be diluted with sterile water, and a small drop of the mixture allowed to flow about over the surface of the serum, in the hope that the germs will settle on it at a distance from one another. But it should be borne in mind that this is an exceptional method which does not give nearly so complete a separation of the germs as the careful distribution in melted gelatin.

Water Analysis.—The bacteriological analysis of drinking water is undertaken according to the rules given above. The following precautions are also to be taken: The water is collected in sterilized glass flasks, with cotton or glass stoppers. If it is taken from a faucet or hydrant, it is allowed to run for some minutes before any is gathered, and care must be taken to prevent the contamination of the stopper from any source (by placing it in a sterile glass box, Figs. 11 and 13, etc.). Samples are taken from accessible bodies of water in sterilized pipettes, and quickly distributed in sterile flasks. In case of deeper, less accessible supplies, a weighted sterilized flask is lowered and drawn up when full, its contents being at once divided between several smaller bottles. The analysis

must be made as soon as possible after the sample is taken; even a few hours' delay at ordinary room temperature effects a great increase in the number of germs. If it is necessary to send samples of water to any considerable distance, or to let them stand for some time before they can be analyzed, they must be packed in ice.

The quantity of water to be added to each tube of gelatin, depends upon the number of germs present in it. When few are present, an entire cubic centimetre may be used. Occasionally $\frac{1}{10}$ cc. suffices. Water that contains germs in especial abundance must be diluted with occasionally several thousand times its bulk of sterilized water, and a drop may even then give a large number of colonies on the gelatin plate. Botton puts 10 colonies to the plate as a minimum, and 5,000 as a maximum, if good results are to be secured. With fewer than 10, accidental contaminations easily vitiate the results. If the plate contains too many, the task of counting them is more difficult, and some of them may not develop enough to become visible. It is best to keep the plates at 20° to 22° C., and to count the colonies on the third or fourth day.

B. Solid Substances.

The bacteriological analysis of solids is quickly described after the detailed account of fluid analysis. It may be carried out exactly like the latter, by first quickly dropping the substance into the melted gelatin, in which the germs are washed out and distributed as far as possible in the manner indicated for the analysis of water. If it is not certain that the germs can be sufficiently washed out even by continued agitation in the liquefied gelatin, this may be effected by violent and prolonged shaking in sterilized water or bouillon, which is afterward investigated according to the rules given for fluids. It is also possible, after such treatment, to add an equal quantity of melted 20-per-cent nutrient gelatin to the water, and, after careful mixing, to spread this out in one of the described methods.

Fraenkel recommends the first method for soil analyses, as the result of a large number of comparative experiment.[4] Because of the great difference between different samples of soil, as regards the amount of water present, he further ad-

vises measuring the samples in preference to weighing them, using for this purpose a sharp-edged spoon holding about $\frac{1}{10}$ cc. A level spoonful of dirt is poured into a test-tube containing melted gelatin, and broken up and distributed in this as thoroughly as possible by the use of a stout platinum needle, and by agitating the glass, after which the procedure is the same as for analysis of fluid. The same writer advises the use of von Esmarch's tube-method (*supra*, p. 495), and counts the colonies two days after preparing the tubes. But the common plate-method is equally applicable and occasionally even preferable, especially when the samples contain many liquefying forms, as is generally the case with the surface soil. A great deal of the difficulty from this cause may be avoided by the use of agar-gelatin. On the other hand, the tube-cultures admit of prolonged observation, and in this way of the detection of those very slowly developing forms which frequently occur in earth (*cf.* Chapter XII., on disinfection). Samples from the deeper soil, which, as the studies of Koch and Fraenkel show, always contain very few germs, can only be obtained with the certain exclusion of dirt from above by the use of a special boring apparatus (made by Muencke, of Berlin). Like water, soil must be investigated very soon after collection, since, especially in samples from some depth, there is a very rapid multiplication of the bacteria, which may become a thousand-fold more numerous than at first, in the course of a few days (Fraenkel). The reason for this increase, which cannot be prevented by the use of ice, is still unknown.

In his first soil analyses, Koch used the simple method of sprinkling the earth over the surface of gelatin. Naturally, no certain separation of the germs is possible by this means, but a good notion is obtained of the kinds of bacteria and moulds present in the sample. It is best for this purpose to pour the sterile nutrient gelatin upon plates or in trays, where it is allowed to harden. The earth is collected with the usual precautions in sterile test-tubes or flasks plugged with cotton. Immediately before use, the cotton is removed and a layer of filter paper quickly tied over the mouth of the glass. Holes are made in the paper with a flamed pin, and through these the dirt is dredged upon the gelatin, so that the fine particles do not lie too close together.

C. Air.

The micro-organisms which float in the atmosphere, and compose an important part of its so-called dust, have been investigated for a long time in many different ways, and with more zeal than those of water and the soil; on the one hand with reference to the theory of spontaneous generation, and on the other, because too much weight was laid upon the importance of the air as a carrier of nearly all contagious matters. But the time and energy bestowed are sadly out of proportion to the small resultant gain in knowledge of the life history and mode of transportation of pathogenie bacteria.

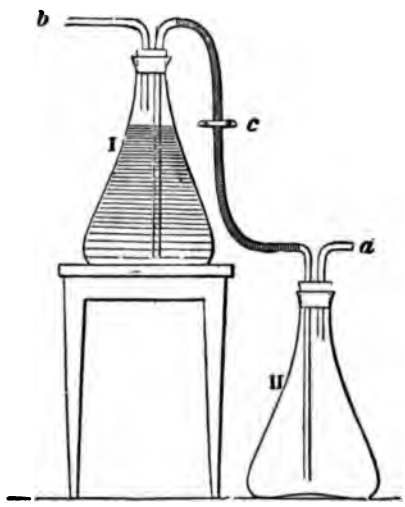

Fig. 33.—Aspirator Made from Two Flasks.

Two modes of collecting air and its organisms are in use:—the dust is allowed to settle by its own weight, or it is drawn into a suitable apparatus by using an aspirator.

Aspirators. — A simple aspirator, easy of transportation, is that shown in Fig. 33. Two large conical flasks (I. and II.) are furnished with rubber stoppers and glass tubes arranged (Fig. 33) as for wash bottles, and connected with a rubber tube in the manner shown. A pinch-cock is placed at *c*, and the upper flask filled with water. When the cock is opened and suction applied at *a* (or the upper flask tipped) till the siphon is filled, the water will flow without interruption from I. into the empty flask II., inducing a uniform and continuous suction of air into *b*, until I. is empty. By pouring the water back into I. (or reversing the relative position of the flasks) the suction can be recommenced. Knowing the volume of water used, and the time taken to empty one flask into the other, the amount of air sucked into the apparatus during a given time is also known. The rapidity with which the water flows from flask

to flask can by regulated by the pinch-cock, or by the use of glass tubes of various calibre, inserted somewhere in the rubber tube. A number of such pieces of tubing are made ready, and the time required for each to permit the passage of a liter of water is experimentally determined and marked on it with a writing diamond, so that according to circumstances a larger or smaller tube is employed (Hesse).

FIG. 34.—Drip Aspirator (Filter Pump).

Another form of aspirator is that shown above in Figure 7.

c. A drip-aspirator is shown in Figure 34 in which the constant stream from a faucet can be used as a means of suction. As the water falls in small portions from the faucet, through the tubes *a* and *b*, the little columns of fluid carry along between them larger and smaller columns of air, producing at *c* a powerful suction, which, however, is not so uniform as in the other two aspirators. [The German dealers supply a very simple aspirator essentially on this model, consisting of a T-shaped brass tube representing *abc*, joined by suitable corks and rubber tubing with a flexible lead tube some yards long, which, being non-collapsible, makes a very good connection with the other apparatus employed.—W. T.] Nor does the apparatus directly indicate the quantity of air sucked through, like the others, so that if this is to be determined it must be used in connection with a gas-meter.

I. *Collection of Dust for Direct Microscopical Examination.* — The dust which has accidentally accumulated in different places, often in a thick layer, can be simply collected, even if the layer is a slight one, or is easily swept on to a piece of paper with a feather. Small quantities of the dust collected in this manner are mingled with a drop of glycerin or

other fluid on a slide and subjected to microscopic and micro-chemical examination in the usual manner.

If the dust is to be collected for a given time and place, this is best done by the use of a so-called aeroscope (Ponchet, 1859). Of the various models, only Schnauer's will be described here—a form which can easily be put together in any laboratory. It consists (Fig. 35) of a bell-glass (*a*) with ground base and short neck. A bottle with the bottom broken off and the lower end ground flat can be made to serve the same purpose. The neck is fitted with a rubber stopper provided with two holes, in one of which a short glass tube (*d*) is fitted, while a longer tube (*e*), bent in an arch above and drawn out to a point with an opening of about 1 mm. at the other end, passes through the second. The ground base of the bell-glass is smeared with vaseline and pressed air tight against a glass plate (*b*). Under the bell-glass is placed a slide (*c*) on which is a small drop of a sterilized solution of grape sugar 1 part, and glycerin 2 parts (Miquel). The tube *e* is then adjusted so that its point is about 1 mm. above the surface of the drop, and the tube *d* is connected with an aspirator. As soon as the suction begins, the air, and the dust suspended in it, flow through the curved tube directly against the drop of glycerin, in which the flow of air causes a slight depression, and where a large part of the dust is stopped. A part settles in the curved tube, which must, nevertheless, have this form in case the apparatus is to be used in the open air in rainy weather.

FIG. 35.—Schoenauer's Aeroscope.

When the aspirator has operated long enough, the slide is removed, and the dust uniformly distributed through the glycerin with a sterilized needle, a cover glass placed on it, and it is ready for microscopic and micro-chemical examination.

Preparations of this sort give a good notion of many of the inorganic and organic substances which float in the air in enormous quantities, *e.g.*, coal dust, sand, small crystals of various salts, woollen and cotton threads, hair, starch-grains,

fragments of vegetable tissue, pollen, etc. Many mould spores are also recognizable, but the germs of bacteria are too small and too little characteristic to be identified in such preparations. The number and character of such germs present in the air at a given time can only be determined by sowing the dust in suitable culture-vessels.

II. *Collection of Dust for Cultures.*—Very pretty and useful preparations are obtained by simply letting the germs settle from the air upon the surface of gelatin. Several pairs of shallow glass trays (Fig. 12) are sterilized at 150°, each pair wrapped singly in paper. The nutrient gelatin (most commonly peptonized meat infusion with agar-gelatin) is carefully and rapidly poured in a shallow layer into the smaller tray, which is at once covered with the other (*cf.* p. 502). When the gelatin has solidified, the trays are wrapped up and taken to the place where they are to be used. Here they are unpacked, the lids (*i.e.*, the larger, upper trays) taken off, and the gelatin is left exposed to the air for a longer or shorter time, varying with the abundance of germs from a few minutes to an hour. After replacing the lids, the trays are set aside at room temperature, for observation, the germs beginning to show evidence of germination after a few days.

It is best to use the sterilized paper to wrap the lids in while the gelatin is uncovered, and, after they are replaced, to again wrap the pairs of trays in it for their return to the laboratory. Instead of pouring the gelatin directly into trays, it may, of course, be spread on a glass plate, which is then set within a pair of trays.

Simple as this method is, it gives, as has been said, very useful results. This may easily be shown by exposing a number of trays of gelatin simultaneously and for the same length of time in two different places. The differences in number and kinds of atmospheric germs in different localities is then very evident. It is to be recommended for the qualitative air analyses most frequently called for, but it does not give the number of germs contained in a given quantity of air. A number of methods and appliances for this quantitative analysis of atmospheric air have been indicated, but there is at present a difference of opinion as to which is to be preferred. I have not sufficient experience in this direction to pronounce very authoritatively on the question, but I have no doubt the air-

filters using (insoluble or soluble) powders are to be given the preference. In view of this difference of opinion it must be a satisfaction to know that at present the exact determination of the number of germs in the air is not of very great importance. I shall, therefore, merely describe briefly the choice of apparatus representing the various systems, viz., automatic suction balloons, settling apparatus, such in which the air is allowed to bubble through fluid or gelatinized contents, and filters, which may be insoluble or soluble.

The automatic balloon was first used by Pasteur in 1860. As shown in Fig. 36, it is at once culture vessel, aspirator, and gasometer. It consists of a globular flask with a long neck drawn out into a capillary tube. The tube is hermetically sealed, and the flask sterilized at 150° C. When cool, the point is broken off, the air within the balloon is warmed a little over a burner, and the tip dipped into the sterilized culture-fluid. As it cools, a few drops of fluid pass into the flask, this is carefully heated to the boiling point over the burner, and, while the steam is escaping from the opening, this is again dipped into the fluid, a greater quantity of which is sucked in. When the flask is about half full, the point is removed from the fluid, and the contents carefully heated over the flame and allowed to boil gently for a couple of minutes. While the steam is escaping with a whistling sound from the end of the tube, the flame is removed, and the point is at once carefully fused. The apparatus is now ready for use, for which it is held as far from the experimenter as possible, in the direction from which the wind comes, so that germs shall not be blown from one's body toward it. The point is opened by a pair of pincers or shears that have been flamed, and the air rushes in with a whistle and fills the receptacle. The opening is once more sealed, the flask shaken so as to wash all germs from the walls into the fluid, and the development of micro-organisms in the fluid is awaited. [But this gives no quantitative determination, and a satisfactory investigation of even the aerobic forms present in the fluid is only possible when some of the fluid after thorough shaking is at once taken, with the usual precautions, as a basis for some form of plate-culture. —W. T.]

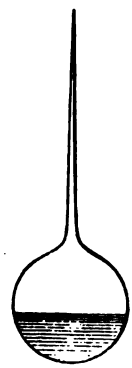

Fig. 36.—Automatic Suction-Bulb for Collecting Air-germs.

Hesse's aeroscope (Fig. 37) consists of a glass tube 50 to 70 cm. long and 4 cm. in diameter, one end of which is somewhat flaring and closed by a perforated rubber stopper (*d*), through which passes a short glass tube 10 mm. in diameter, plugged with cotton (*b*). The flange at the other end is somewhat more prominent; over it are tied two thin rubber caps, one outside the other, the inner of which is pierced with a round hole about 10 mm. in diameter, as shown in the section in Figure 37. The tube is used with nutrient gelatin, the surface of which must not reach above the lower side of the small glass tube or the hole in the inner cap, when the apparatus lies flat.

Fig. 37.—Hesse's Aeroscope.

The tube, stopper, and caps are cleansed in 1.0 per cent sublimate solution, and finally rinsed with boiled water. The inner cap is tied fast with thread, without being much stretched. If it is found to be water-tight, by half filling the tube with water, and holding this end downward, the round hole (*f* and *f'*) is clipped in its centre with sharp scissors, and the outer cap is tied over it, but in a more tense condition. [Rubber caps, fitting quite well and easily applied, are also supplied with the apparatus by dealers.—W. T.] Its power to hold water is then again tested. The stopper with its plugged tube in place is now inserted in the other end, and the apparatus, still containing water, is hung in the steam cylinder, which needs to be lengthened for this purpose (Fig. 4, C). A piece of wire (Fig. 37, *c*) twisted around the upper end is used for suspending the tube to the lid by the means shown in Figure 4 A. After exposure to streaming steam for a quarter of an hour, it is removed from the sterilizing cylinder, and when it is somewhat cooled the water is poured out and replaced with all precautions by melted sterile nutrient gelatin, poured from a pipette or wash-bottle. The stopper being again in place, it is once more hung in the steam-cylinder

for ten minutes' sterilization at 100°, after which it is placed horizontally while the gelatin cools [or rotated until the gelatin is nearly hard, when it is allowed to lie flat so that one part of the circumference is more thickly coated than the rest. —W. T.] When wanted for use, it is set upon a suitable support, where the air is to be examined. Hesse uses a folding tripod such as is used by photographers, which ends in a flat surface on which the tube can be fastened, the two flasks of the aspirator (Fig. 33) being hung at different heights on the legs. Simple supports, answering every purpose, are also easily improvised. When the apparatus is set up, it is connected with the aspirator, the surface of which is carefully washed with 0.1 per cent sublimate, and the aspirator set in operation, the siphon being sucked full beforehand, to prevent a sudden irregular suction when the pinch-cock is opened. The quantity of air which Hesse advises to be passed through the apparatus is 1 to 5 litres for inhabited rooms, and 10 to 20 litres out of doors, but in certain cases much greater or smaller quantities may be advisable. He recommends the aspiration of a litre of air through the apparatus in one to three minutes for inhabited rooms, and the same quantity in three to four minutes for the open air, as a proper rapidity. After the air has been sucked through, the apparatus is closed by replacing the rubber membrane (which has been rinsed in sublimate), and set aside at room temperature. In the course of the next eight or ten days, colonies of moulds and bacteria grow on the surface of the gelatin, from which they can be obtained for examination and the inoculation of cultures by using a long glass rod bearing a platinum needle. If the suction has been effected sufficiently uniformly and with the right rapidity, so that all germs have been allowed to settle from the air passed through, the colonies should be most numerous near the end through which the air enters, gradually decreasing in number toward the other end, the last third or quarter of the gelatin surface being entirely free from colonies.

Bubbling Apparatus.—Of the different forms with fluid contents, only one, long employed by Miquel, is described here. This is a flask closed above with a cap plugged with cotton (*a*), like a Pasteur flask (*cf.* Fig. 10). The neck is prolonged as a fine tube to the bottom of the flask. The slightly constricted side tube *b*, is plugged at two points with cotton (not

shown in the figure), and is connected with some form of aspirator by the rubber tube *e*. A capillary tube hermetically sealed at *d*, is connected by the same means with the other lateral tube (*c*), which is slightly bent downward. 30 to 40 cm. of distilled water is poured into the flask. Sterilization is effected as usual. The aspirator is connected with *e*, the plugged cap *a* is flamed and removed, the observer withdraws from the apparatus, and the suction of air into it is allowed to go on, after which the cap is again flamed and replaced. By blowing through *e* the water is made to rise and fall through the neck of the flask ten times, to wash off adhering germs. The point *d* is flamed and broken off and by tipping the flask and blowing through *e* the contents are divided among 30 or

FIG. 38.—Miquel's Aeroscope.

40 culture flasks containing bouillon. Finally, the outermost of the two cotton plugs in the tube *b* is removed and the inner one pushed into the flask with a sterilized platinum wire, after 25 cc. of sterile bouillon has been poured into the flask. The flask, and the 30 culture-vessels are set aside at 30° C., and observed for at least a month. When a small number of the vessels show growth, the total of the germs collected by the aeroscope can be approximately calculated (*cf.* p. 480, method of dilution).

Tryde, Hueppe, and v. Sehlen formerly caused air to bubble through melted nutrient gelatin, in their aeroscopic analyses. Quite recently, Straus and Wurtz have used the same method, and for this purpose produced the glass apparatus shown in Figure 39. The top and bottom measure 15 mm. in diameter, while the central portion (*A*) is a wide cylindrical receptacle bearing the slightly constricted lateral tube (*D*), with two

cotton plugs (*f* and *g*). The tube *B* is drawn out to a fine point below, and closed above with a cotton plug (*e*). At *c* it is widened, and ground to fit the mouth of *A* air-tight. The apparatus is sterilized at 150° C., after which 10 cc. of 10 per cent gelatin (or preferably agar-gelatin) are poured into it and a drop of sterilized olive-oil added, after which all is sterilized in the steam cylinder. The addition of oil prevents the gelatin from foaming, even when air is passed through it very rapidly, *e.g.*, 50 litres in ten minutes. The gelatin is melted, *D* is joined by rubber-tubing with an aspirator, and the plug *e* is removed. While air is passing through, the gelatin is kept fluid by the warmth of the hand, or, if agar-gelatin is used, a water-bath is employed. Afterward, the plug *e* is replaced, and, by blowing into *D* the fluid is forced into *B* several times to wash out any adhering germs. The plug *f* is removed so as to allow *g* to be pushed into the gelatin with a sterile platinum wire, after which it is replaced and *g* is gently shaken about in the gelatin, which is then allowed to solidify as for an Esmarch tube-culture, or poured out in glass trays as described on pages 496, 497. The observation of the development of the colonies is rendered not a little difficult by the fact that, while air is bubbling through, the oil becomes finely emulsified in the gelatin, rendering it cloudy.

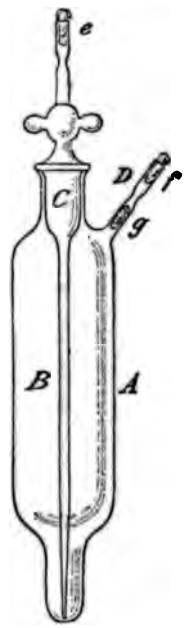

FIG. 89.—Aeroscope of Straus and Wurtz.

Insoluble Powder Filters.—As the result of a series of very carefully conducted experiments, Petri has recommended sand as a filtration medium in preference to glass-wool and asbestos, which have been used by others (Miquel, Moreau, Freudenreich, and Frankland). The details of his method are as follows: sand is passed through a sieve with meshes 0.5 mm. wide, and what passes this is sifted through a second with meshes 0.25 mm. wide, the portion that remains in this consisting of grains of the right size. This sand is heated to redness in an iron crucible (half or three-quarters of an hour being required for 100 cc.), while it is stirred with a glass rod. While warm, it is filled into sterile test-tubes plugged with cot-

ton. Two sand-filters (s_1 and s_2) 3 cm. long are brought into a glass tube 1.5 to 1.8 cm. wide and 9 cm. long, as shown in Figure 40. The sand is held in place by small caps (n_1 to n_4) of fine brass gauze (40 meshes to the linear centimetre), which are easily made over the end of a glass tube or metallic rod. This separation of the sand in two parts enables the experimenter to sow the second sand plug separately, as a control filter. The filters being 1 cm. from each end of the tube, it is plugged at *f* and *g* with cotton, and sterilized at 150° C.

FIG. 40.—Petri's Sand-Filter.

Before use, the cotton plugs are removed and laid aside in a sterilized glass box. The filter-tube is joined with an aspirator by means of a rubber stopper (*a*) sterilized in sublimate, pierced for a cotton-plugged sterile glass tube *c*, which is connected by a short piece of rubber tubing with a lead tube (*e*) 0.5 cm. wide. The filter tube being arranged vertically, the cotton plug is removed from *g* and the suction can begin. Petri uses as an aspirator a hand air-pump, each stroke of which draws a litre of air through the filter. When, as in his experiments, 100 litres pass through the filter in 10 to 20 minutes, all germs are stopped by the first filter. The material is sown in pairs of trays (Fig. 12) 9 cm. in diameter, the sand of the first filter being divided between three, and of the second, between two such trays. The sand is first poured into the trays, and melted gelatin is poured over it from test-tubes (*cf.* p. 496). After the sand is completely wet by the gelatin, so that all air bubbles have been driven out, it is equally distributed by a series of short but forcible horizontal movements, and the gelatin is allowed to harden, when the three pairs of trays are set away one over the other at the temperature of the room.

Soluble Filters.—Miquel, the most experienced living student of the air, has very recently recommended[5] the employment of soluble filters, an ingenious method suggested by Pasteur over twenty-five years ago. Of the various powders which may be selected (cane-sugar, table-salt, sodium phosphate, magnesium sulphate, etc.), Miquel recommends cane-sugar, which demands no special preparation, may be steril-

ized at 150° C., without losing its high degree of solubility or becoming more hygroscopic, or without having any injurious effect on the bacteria. In very foggy weather it may become impossible to work with either insoluble or soluble filters. In this case a bubbling apparatus may occasionally have to be used. The sugar (if loaf sugar is used) is powdered in a mortar and shaken through two metal sieves, as described for sand, so that the size of the grains used is about half a millimetre. This sugar is placed in an aeroscope (Fig. 41, *A*) consisting of a glass tube about 20 cm. long and 5 mm. in diameter, narrowed at *e*, and, according to the suggestion of Freudenreich, provided at *b* with a ground cap plugged with cotton, as for the Pasteur-Chamberland flasks. Two plugs of (glass-wool or) cotton are inserted at *d* and *f*, and the whole is sterilized at 150° C. The cap is removed, and enough well-dried sugar (1 to 2 gm.) is poured into the tube to fill it for a length of 8 to 10 cm., after which all is again sterilized at 150° C. When it is to be used, by a series of light percussions the sugar is packed against the plug *d*, and the tube held nearly vertically (tipped toward the wind), so that during suction the sugar may not fall away from the walls, thus rendering it possible for the air to pass unfiltered at any point.

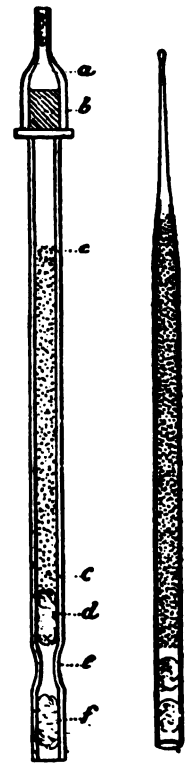

FIG. 41.—*A*, Newer, *B*, Older Model of Miquel's Soluble Powder Filter.

The air is drawn through the filter with different rapidity and for a varying length of time, according to circumstances. The average number of germs for the day at a given point is obtained by slowly drawing the air through a filter for 12 or 24 hours. To learn the number at a given time, it is necessary to draw the largest possible quantity of air through the sugar in the shortest time possible.

After the aspiration, the cotton or glass-wool plug is removed and the sugar is poured into sterilized water. When many germs are expected, a large quantity of water (500 to

1,000 cc.) is used; otherwise a smaller quatity (50 to 100 cc.) is taken.

In case the sugar does not run out of the tube easily, it must be pushed out by the aid of the cotton plug *f*, and a sterile glass rod introduced at *f*, and the tube afterward rinsed out with sterile water. The plug *d* is also to be sown separately as a test of the efficiency of the filter, which should remain free from germs after the air has been sucked through. To simplify these manipulations, I advise the use of tubes that are not constricted at *e*, and to proceed as follows: The following articles are to be made ready beforehand: 1, an Erlenmeyer flask, filled with sterile water; 2, a short test-tube, with a few cc. of water; 3, a test-tube with nutrient gelatin; 4, a sterile glass box (Fig. 11 or 13); 5, a small rubber tube. The plug *f* is removed with forceps, and laid in the glass box, after which *d* is similarly removed and cast quickly into the gelatin, *f* being immediately replaced. The cap *a* is then taken off, and the sugar poured out into the Erlenmeyer flask, the rubber tube is slipped over the unground end of the glass (*f*). the ground end being dipped into the sterile water of the short test-tube, when all remaining germs and sugar are rinsed out by alternately sucking water into the tube and expelling it; finally this water is poured into an Erlenmeyer flask. The filter tubes which Miquel used in his earlier investigations were drawn out to a capillary point at the end through which air was admitted (Fig. 41 *B*, where the constriction between the two cotton plugs is also left out), and were opened and closed by breaking off and remelting the point. The use of the ground cap *a* renders it far easier to empty the apparatus, but adds materially to its expense ; there is, however, no reason why simple glass tubes, closed by my rubber-tubing cap (*cf.* Fig. 9, III.–VI.) should not be used. The gelatin in which the plug *d* was placed should remain sterile, all germs being found in the Erlenmeyer flasks. When the sugar is entirely dissolved and the solution well shaken, the number of germs is determined exactly as described for water analysis, preferably using agar-gelatin, so as to avoid as far as possible the disturbing liquefaction of the gelatin.

A great advantage of this method is that only a fraction of the sugar solution and the germs it contains need be used for quantitative analysis, while the greater part can be used

for various qualitative investigations (*e.g.*, a search for anaerobic forms), which it was not possible to carry out in the earlier methods in which all of the collected germs had to be used for the quantitative analyses.

Of the aeroscopes and methods of analysis here described, the first two have really only historical interest. The automatic suction balloon was the instrument with which Pasteur long since outlined the bacteriological topography of the atmosphere, which Miquel has since persistently worked upon. Hesse's apparatus marks the first attempt to employ the gelatin cultures of Koch in quantitative analysis of the air. Of the other four, doubtless the solid filters will deserve preference. They are easily transported, and can be "charged" with bacteria at any temperature and at places far from the laboratory, after which they can be kept (at least for several days) until cultures can be started under favorable conditions. They also accomplish what is possible toward collecting in a relatively short time all germs from the air of a very large space. Of these solid filters, the soluble appear to me far superior to the insoluble.

In this chapter, we have as good as exclusively concerned ourselves with the application of Koch's methods of isolation in gelatin to bacteriological analysis. It must, also, be said unqualifiedly to be the chief method of such analysis. Starting plate-cultures in one or other of the described forms is the means first to be employed when bacteria are to be found and separately cultivated from a given substance, and they will in most cases lead to the desired result if sufficient attention is given to varying the culture-material, temperature, time of observation, number of germs, etc. The later the colonies are counted, the more probability will there be that all germs have developed into visible colonies. It is not so much the danger of atmospheric contamination which leads to an earlier examination than might be wished, as the presence of rapidly growing, liquefying bacteria and moulds, which quickly spread, so as to cover large portions of the gelatin. But it is self-evident that it is not a universal method in the sense of rendering every other method superfluous. On the contrary, we may often do well to use the various other methods described in Chapter IV., either alone or as complementary; but no

general rules can be given as to this, so that one must choose his plan for each respective case.

Finally, a most important point must be noted with reference to all the methods thus far described, viz.: They are calculated for only aerobic bacteria. An exhaustive analysis of an unknown mixture of bacteria, includes also a determination of the pronouncedly anaerobic forms, which play so important a part in the economy of nature, as well as in the causation of disease. In what precedes, these have been left entirely out of consideration, being reserved for special and detailed discussion in the next chapter.

CHAPTER VIII.

CULTURE OF ANAEROBIC BACTERIA.

In 1861, Pasteur made the surprising discovery that organisms exist which can live, nourish themselves, and propagate, without access to free oxygen. His doctrine of anaerobiosis ("la vie sans air") was received with doubt and mistrust; but further investigation not only corroborated his observation, but from this as a starting point, Pasteur succeeded in leading the physiology of respiration into new channels, bringing us nearer to an understanding of many important processes of fermentation. Anaerobiosis showed itself to be a very significant and wide-spread phenomenon, and a closer investigation of the need for oxygen of different bacteria (as well as yeasts and moulds) revealed an extreme variability in this respect. Some bacteria demand a very abundant supply of oxygen, while others are affected by it as a poison, which not only hinders their development, but quickly destroys their life. Between these extremes—the marked aerobiotic and anaerobiotic forms—every degree of transition is to be found. Some forms seem to thrive about equally well with or without free oxygen; some grow freely exposed to oxygen of a low tension, others when this is greater—a circumstance which occasionally finds expression in a very striking manner in the form and appearance of gelatin cultures. While the growth around the puncture made in the gelatin occurs for many species very abundantly at and immediately below the surface, and diminishes toward the bottom (Fig. 42, *c*), other cultures may be found (Fig. 42, *a*) which show an extremely slight growth near the surface, while the colonies of bacteria increase uniformly in size the further they are removed from the atmosphere. The former is consequently aerobic, the latter anaerobic. Beside these more or less conical cultures, with the point directed downward or upward, others occur as capil-

lary or thick cylinders along the needle puncture (Fig. 42, *b*). The oxygen of the air has neither helped nor hindered the growth of these.

The discovery of anaerobiosis has necessitated the introduction of new apparatus and methods in the cultivation of bacteria. These must be treated now in detail, especially since we already know several pathogenic forms which are markedly anaerobic (malignant œdema, charbon symptomatique). Very different means have been employed for keeping the oxygen of the air from culture vessels and material,

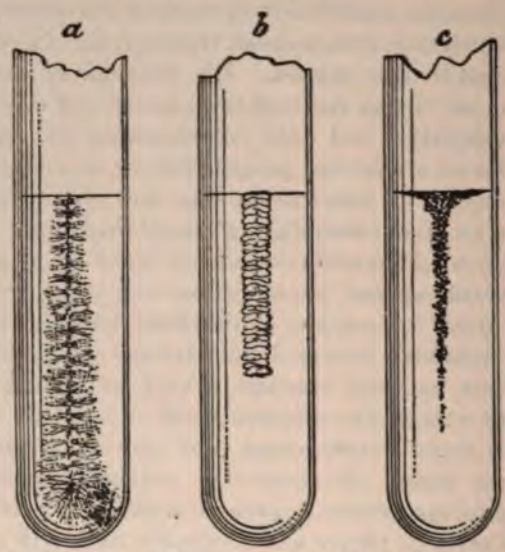

FIG. 42.—Test-tube Cultures, *a*, *B. murisepticus*, in agar-gelatin; *b*, a colorless yeast in raisin-gelatin; *c*, *B. Anthracis*, in agar-gelatin. The three cultures are of like age, and grown under exactly the same conditions.

or for removing all absorbed oxygen from the latter. Sometimes the effort has been limited to covering the culture-medium with solid substances (glass, mica, agar-agar), fluid (oil), or gas (carbonic acid, hydrogen). If good results are desired, the free oxygen held by the culture-medium must also be removed by boiling, the use of the air-pump, the passage of a gas which is not a supporter of combustion, but at the same time not poisonous (hydrogen), or by the aid of aerobic bacteria or chemicals with an affinity for oxygen.

Examples of most of these methods are described below.

though I shall confine myself to a discussion of a limited number of kinds of apparatus which have received the recommendation of expert investigators. In accordance with the plan of the book, the principal weight will then be laid on such methods as demand the most readily obtainable and cheapest material. Those who wish to go further into the technology of this branch of the subject are referred to the two chief treatises on the subject, by Roux [6] and Siborius.[7]

Even by the best of the methods described, it is not possible to remove the last trace of oxygen from the culture-vessels, but they have shown themselves sufficiently free from oxygen under all circumstances for the cultivation of the most pronouncedly anaerobic forms. As an easily applied test for freedom from oxygen, sufficiently accurate for our purpose, indigotin is to be recommended. Enough of a very dilute solution of the sulphate (1 gm. indigotin to a litre of water) is added to the culture-medium to give it a distinct blue color, a small quantity of grape sugar is added, and the reaction rendered distinctly alkaline by the addition of potash. Three drops of a 10-per-cent solution of potash are added to 10 cc. of nutrient gelatin or agar, which in addition to the usual substances also contains 1 per cent of grape sugar (Liborius). When (by means of boiling, the passage of hydrogen, or the use of the air-pump) the oxygen absorbed by the blue culture substance is removed, the latter becomes colorless, since the indigo-blue is reduced by the grape sugar to indigo-white. A return of the blue color shows that oxygen is not certainly enough excluded.

Trustworthy and adequate apparatus for the cultivation of anaerobic forms can only be prepared when a hydrogen developer or air-pump can be used. For the former, Kipp's apparatus is commonly used, though, as Jörgensen has shown, any one can fit up a sufficiently good generator at a cost of about half a dollar, by using a common student-lamp chimney, fitted by a loose cork (Fig. 43, *a*) into a cylindrical glass which contains a mixture of one part by weight of sulphuric acid and eight parts by weight of water (prepared with care by adding the acid to the water while it is being stirred,—never by adding water to the acid), and a couple of drops of platinum chloride solution. A perforated lead plate covered with muslin is placed at *b*, to support a quantity of granulated

zinc in pieces about as large as peas. The stopper *c* must be of rubber, and fit perfectly. Hydrogen is evolved as soon as the zinc is brought in contact with the acid; but if the rubber tube at *d* is closed by a pinch-cock, the hydrogen drives the acid down to below *b*, and its formation stops, to recommence when the pinch-cock is again loosened. On the way to the culture-vessels, the gas is passed through an alkaline solution of pyrogallic acid (*e*) (1 part of a 25-per-cent aqueous solution of pyrogallic acid is thoroughly mingled, in a perfectly full bottle, with a 40-per-cent solution of potash) to remove a trace of oxygen which may be present.

The air-pump belongs to the class of expensive instruments which it is not proposed to discuss here in detail. It is, indeed, a great comfort to have the use of a mercurial air-pump when the cultivation of anaerobic forms is to be undertaken, but it is not a necessity. A comparatively cheap and good model is the Sprengel pump, as modified by Hüfner. One of the simple water air-pumps cannot be relied on for the removal of oxygen as completely necessary: but by also employing hydrogen by Roux (*infra*, p. 526), it may be effected with

and methods for cultivating anaerobic forms under two principal classes, according as for isolating and obtaining pure cultures from a mixture of bacteria, or merely for already pure, either in culture or in a

1. Isolation from a Mixture of Species.

successful in getting the first pure cultures of anaerobic forms in fluid media, by the method of isolation based

on physiological differences of species, using carbonic acid or exhausting the air. More recently, the attempt has been especially made to apply Koch's methods with gelatinized media, even to the analysis of mixtures containing anaerobic bacteria.

A. Simpler (and more incomplete) means, which do not require the use of either air-pump or hydrogen generator.

1. *Plate Cultures under Mica* (Koch).—Koch made the attempt to effect the plate-culture of anaerobic forms by covering the gelatin, while still soft, with a sterile sheet of mica. This must usually be as thin as a sheet of paper, without flaws, and sterilized by flaming immediately before use (or at 150° C., wrapped in paper), and care is to be taken not to allow air-bubbles to slip under it when it is laid on the gelatin. To secure a still surer exclusion of oxygen, the margin of the mica can be covered with melted paraffin (Fraenkel), which quickly hardens, forming a solid border. In this way, the usual method of working is preserved, as well as an easy accessibility for microscopic examination.

It is easy to convince one's self that the mica plate really hinders the access of oxygen to germs beneath it, to no small degree. If a decidedly aerobic non-liquefying form has been plated out in this manner, the colonies may be seen to appear in numbers in the uncovered part of the gelatin, while beneath the mica they occur sparingly near the margin, and in the beginning may be entirely wanting in the centre. Yet the method is frequently unsatisfactory, because the exclusion of oxygen is not sufficiently complete and lasting, and it is inferior to those described below, especially that recommended by Liborius.

2. *Isolation in a Very Deep Solid Medium* (Liborius).—A small quantity of the mixture to be analyzed is sown in a test-tube filled to a depth of 10 to 20 cm. with nutrient gelatin or agar, which has been melted and cooled to the lowest temperature at which it will remain fluid. The material is distributed as uniformly as possible by aid of a thin sterile glass rod carried carefully through a rotary as well as vertical movement in the gelatin. If the distribution is successful, and the number of germs right, very pretty results may be obtained, the number of aerobic forms decreasing in size and number from the top, while on the other hand the anaerobic forms

grow only toward the bottom, and are always wanting from the uppermost part of the gelatin. In either case, the distribution of the colonies always gives a good basis for deciding as to their need of oxygen.

The colonies of bacteria are naturally far less easily accessible for examination in the depth of such a test-tube than in a plate-culture. When there are few of them, and each colony is large and liquefies the gelatin, material for new cultures or for examination is easily obtained by thrusting a sterile capillary tube, open below but sealed at top, through the gelatin until the colony is reached, when the top is broken off. In other cases, it may be necessary to break the tube and to cut the gelatin up in a sterile tray so as to render the colonies accessible to the needle. If agar is used, this can usually be blown out of the tube by means of a Pasteur pipette (p. 483) passed down at one side. The microscopic examination of the colonies under moderately high powers can likewise often be conveniently made only after removing the contents from the glass and cutting it in thin slices.

FIG. 44.—Isolation-Culture of Anaerobic Bacteria in a Deep layer of Gelatin.—(Liborius.)

B. Methods in which hydrogen is used to replace the air.

3. *Isolation in Gelatinized Media.*—Roux recommends a tube similar in all essentials to that shown below in Figure 56, but of considerably larger size. After hydrogen has been passed for a sufficiently long time through the liquefied and inoculated gelatin, this is allowed to solidify while the tube is horizontal. When the colonies are developed, the tube is cut lengthwise with a diamond into two boat-shaped halves, the one containing the gelatin being then easily accessible for observation.

Fraenkel uses the following method: The test-tubes, rather thick-walled, of large diameter, and without spreading rims, are plugged with cotton sterilized in the usual way, and inoculated in three degrees of dilution as described on p. 500, after which the plugs are replaced as rapidly as possible, with sterilized fingers, by closely fitting rubber stoppers with double

perforation, containing two glass tubes bent at right angles above the stopper. One of these reaches the bottom of the test-tube, while the other ends immediately below the stopper. The horizontal branches are contracted to capillary cavities near the ends, which are plugged with cotton. The stopper and tubing must be carefully sterilized, before the test-tube is infected. This is done exactly as described above (Chamberland filter, p. 449), *i.e.*, by sterilizing the stopper in 0.1 per cent sublimate, and the tubes at 150° C., both being wrapped in paper and finally sterilized by steam after being set up in an autoclave; the stopper and tubing can, of course, be quickly sterilized together. Just before being used, the rubber stopper is unwrapped, the long tube drawn through the flame, to be sure of its sterilization, and the stopper firmly fixed in the test-tube, after which it is coated with paraffin, especially about the small tubes and where it meets the side of the test-tube. The long tube is now connected with the hydrogen generator, while the test-tube is kept at 37° C. by the use of a water-bath. According to Fraenkel, the rapid passage of hydrogen for four minutes insures the removal of free oxygen, after which the two tubes are sealed by melting at the constrictions, and the test-tube is rotated under a stream of cold water until the gelatin has solidified upon the walls. By this means a "roll-culture" of anaerobic forms is ultimately obtained (Fig. 45).

4. *The Capillary Tube Method.*—This is obviously applicable to the isolation of anaerobic species, and has been especially recommended for this purpose by Klebs and Vignal. The latter advises its combination with the passage of hydrogen and the use of solid culture-media. A small quantity of nutrient agar or gelatin is brought to the boiling point and allowed to cool off while a constant stream of hydrogen is passed through it by means of a bent Pasteur pipette inserted between the wall of the test-tube and its cotton plug (Fig. 46). By use of a water bath the gelatinized contents are prevented from solidifying. The tube is infected while hydrogen is passing through. After this has been continued a few minutes longer, and while the stream is still passing, the gelatin is quickly sucked up into capillary tubes about 50 cm. long, which are sealed at both ends and can be fastened later upon black cardboard.

C. Methods depending upon the use of the air-pump.

Where an air-pump can be had, a very simple culture-apparatus (Roux, Fig. 47) can be used. This is closed by a cotton plug and contains a rather small quantity of nutrient gelatin. After the latter is infected, the plug (*a*) is crowded down to the constriction *c*, the tube is softened and slightly constricted at *b*, and the gelatin remelted. By means of a piece of rubber tubing, the tube is connected with the air-pump, and the air exhausted from it, the glass being meanwhile carefully warmed by passing a gas or spirit flame up and down its sides at short intervals. When the air is exhausted, the tube is melted at *b*, which hermetically seals it and at the same time separates it from the air-pump. A "roll-culture" is finally obtained by allowing the gelatin to harden in a thin layer on the inside of the tube.

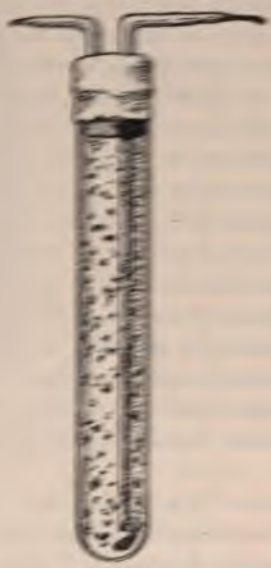

FIG. 47.

FIG. 48.

FIG. 47.—Roll-culture of Anaerobic Bacteria (Fraenkel).

FIG. 48.—Use of a Bent Pasteur Pipette for Passing Hydrogen through Gelatin Preparatory to Making Capillary Tube-cultures.

According to Roux, a small water air-pump (filter-pump) is sufficient if, by means of a T-tube with two glass stop-cocks (*Fig.* 48), the culture-tube is likewise joined to a hydrogen

rator, and the exhaustion of the air alternated five or six s with the admission of hydrogen.

Having now explained how pure material of anaerobic

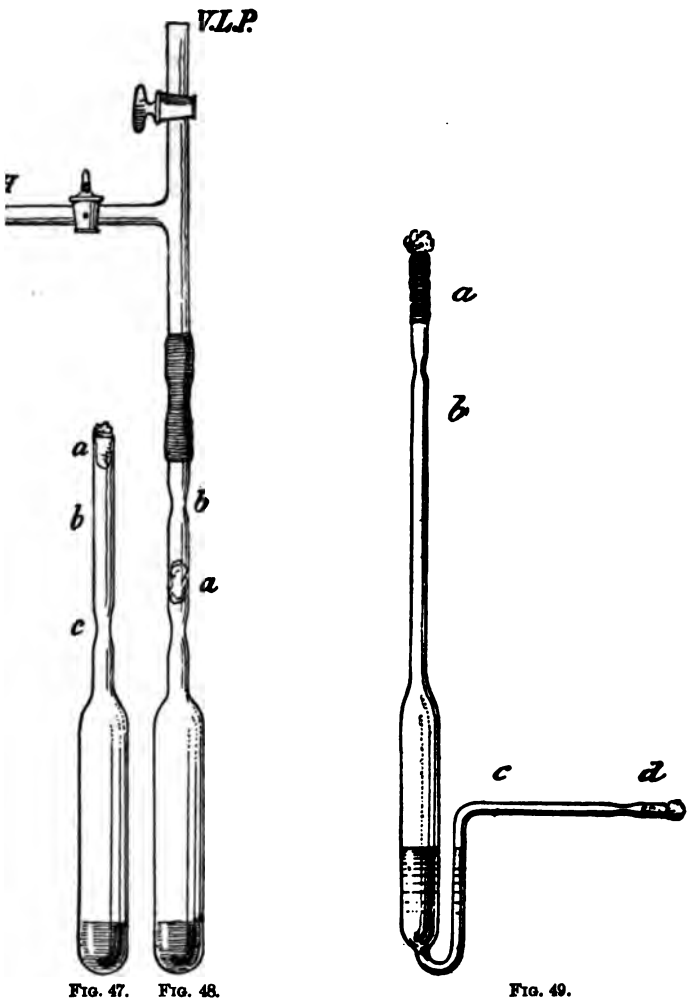

FIG. 47. FIG. 48. FIG. 49.

. 47.—Culture-vessel for Isolating Anaerobic Bacteria in Gelatin in a Vacuum (Roux).
. 48.—The Same Apparatus Arranged with T-tube for Alternating Connection with pump and Hydrogen-generator (Roux).
. 49.—Vessel for Cultivation of Anaerobic Species under Hydrogen (Salomonsen).

s is obtained by cultures in solid media, it remains briefly plain the use of fluid media for the same purpose. Three

courses are open, so that it is possible to employ the capillary-tube method, as described on p. 525, or the method of dilution, by adding a drop of the greatly diluted substance to each of a large number of culture-flasks, which may then be used for cultures under hydrogen or in a vacuum.

For the passage of hydrogen, culture-vessels like that of Fraenkel (Fig. 43) may be used, or my own (Fig. 49), in which the part used for the culture is about 10 cm. long and 2 cm. in diameter. The contents are inoculated through the vertical tube, closed at top by a cotton-plugged rubber tube (*a*),

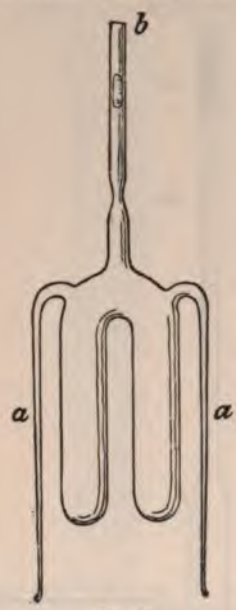

Fig. 50.

Fig. 51.

Figs. 50 and 51.—Two Culture-vessels after Pasteur.

and hydrogen is admitted through the bent tube, provided at *d* with an ordinary cotton plug. Just behind each plug, the tubes are narrowly constricted just before the hydrogen is passed through, and as soon as the stream is discontinued the apparatus is hermetically sealed at these points. If the tubes are made long enough in the first place, these vessels may be used several times in succession.

Vacuum-cultures may be made in Roux's tubes (Fig. 47), or in those shown in Figures 50 and 51, which have been con-

stantly used in Pasteur's laboratory for many years. These are filled through the capillary tubes (*a*), by applying suction at *b*, after which the fine tubes are hermetically sealed and the hole sterilized. The contents are inoculated by sucking some of the questionable material in through the tube *a*, after this has been heated to redness and bent away from the larger tube, and its end flamed and broken off, to be subsequently melted together again. The apparatus is connected with the air-pump by means of rubber tubing. Figure 50 shows a similar vessel in which two cultures may be carried on simultaneously, or first in one receiver and later in the other, by carefully pouring a drop into it from the first.

II. Preservation of a given Anaerobic Culture.

For keeping a pure culture upon solid media, all of the appliances recommended above may be used, and isolated-colony cultures obtained, which, as a rule, are attended by no inconvenience. If thrust-cultures are desired, other methods must be employed, such as the following four:

Fig. 52. — Cultivation of Anaerobic Species under Oil or Agar.

1. *Use of Oil or a Gelatinizing Plug.*— The inoculation-thrust is made as usual in a tube of agar or serum, but with a glass needle in preference to platinum (p. 484). Immediately afterward, a layer 5 cm. thick of olive-oil previously sterilized by boiling, or of sterilized 2-per-cent agar which has been allowed to cool to about 40° C., is poured into the tube, with the usual precautions. The advantages and disadvantages of each of these substances are self-evident.

2. *Use of Entirely Filled and Hermetically Sealed Tubes* (Roux).—A tube of the form shown in Fig. 53 *a*, is plugged with cotton at its upper end, and the lower capillary portion is sealed by fusion, after which it is sterilized by hot air at 150° C. Sterile nutrient gelatin or agar is brought to the boiling point, and as soon as it has ceased boiling the opened capillary end of the tube is dipped into it, and the tube is filled up to the constriction, by suction.

By pressing a finger tightly over the upper end, and quickly raising the tube into an oblique position, the gelatin is prevented from running out of the end, which is at once sealed in the flame. The upper end is likewise sealed by fusion at the constriction just above the gelatin. When the contents are to be inoculated, one end is opened, a thrust is made with an infected fine glass needle, and the tube is again sealed. When the developed culture is to be examined, it is best to open the end opposite that from which the thrust was made, otherwise the colonies can easily be forced from the tube by the pressure of gas generated during their growth.

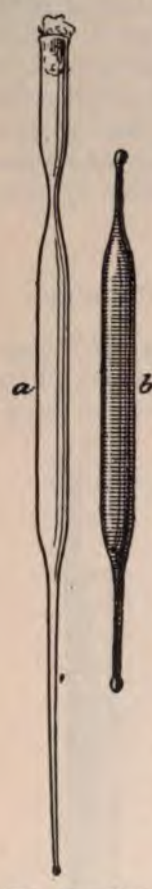

FIG. 53. — Pipette Tubes for Cultivating Anaerobic Species (Roux).

3. *Removal of Oxygen by the aid of Aerobic Bacteria.*— Roux's method is as follows: A suitable quantity of nutrient agar is boiled in a cotton-plugged test-tube, and quickly cooled in cold water. Immediately after it has become solid, it is inoculated by a glass needle, after which a small quantity of melted but not too hot nutrient jelly is poured into the tube, and, as soon as it has solidified, a couple of drops of *bacillus subtilis*, or some other decidedly aerobic species, are sown upon its surface. The test-tube is then fused together at top, and set in the brood-oven. *B. subtilis* grows rapidly upon the surface, using up the oxygen above it, and so preventing this from reaching the agar, in which the anaerobic form is consequently permitted to grow undisturbed. To obtain material for transfers from this culture, the tube is opened by breaking off its bottom, to avoid the admixture of *B. subtilis*.

Cultures can also be made in the apparatus shown in Figure 54, where the mixture of the two forms is entirely avoided. The inner tube is filled by means of a Pasteur pipette with agar-gelatin, and the space about it, with bouillon; the former is inoculated with the anaerobic form, the latter, with the aerobic species, and the outer tube is sealed hermetically at *a*.

4. *Removal of Oxygen by Pyrogallic Acid.*—Buckner has recently recommended the following method: The anaerobic form is sown in a small cotton-plugged test-tube containing agar, immediately after the latter has been boiled and rapidly cooled down. This tube is then supported on a simple wire stand (Fig. 55) [or a piece of spiral spring] in a larger test-tube, the lower part of which contains an alkaline solution of pyrogallic acid (1 gm. of pyrogallic acid; 10 cc. of 10-per-cent solution of caustic potash). The larger tube is carefully closed by a tightly fitting rubber stopper, which is slightly moist-

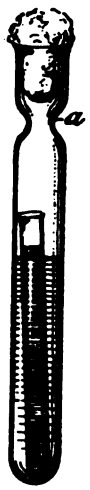

Fig. 54.

Fig. 55.

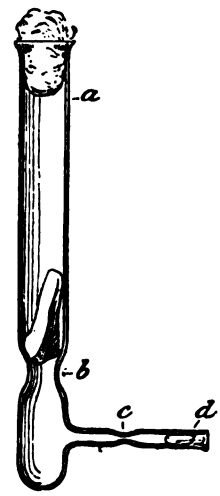

Fig. 56.

Fig. 54.—Method of Cultivating Anaerobic Bacteria by Aid of Others which Exhaust the Oxygen (Salomonsen).

Fig. 55.—Apparatus for use of Pyrogallic Acid (Buchner).

Fig. 56.—Arrangement for Cultivating Anaerobic Species on Potato (Roux).

ened on the sides, and the culture is usually set in the brood-oven at a little over 30° C. Buckner has satisfied himself that the development of so markedly anaerobic a form as the bacillus of malignant œdema is easily effected in this apparatus, though a little slowly. Absorption of the oxygen is hastened by forcibly shaking the tube now and then.

5. *Potato-Cultures in a Vacuum.*—Roux employs the apparatus shown in Figure 56 for this purpose. After the piece of potato has been sterilized in the steam-cylinder, and the condensed moisture has collected at the bottom of the tube,

below the narrowed portion *b*, the potato is inoculated in the usual way, and the test-tube hermetically sealed at *a*. The small lateral tube is then connected with the air-pump, the exhaustion is kept up for several minutes, so that all air may escape from the interior of the potato, and the tube is sealed by melting at *c*.

The preservation of anaerobic pure cultures in fluid media is exposed to no difficulties. The apparatus adapted to the passage of hydrogen (Fig. 49), or to the use of the air-pump (Figs. 47, 50, 51), is employed.

CHAPTER IX.

CULTIVATING MICRO-ORGANISMS UNDER THE MICROSCOPE.

If it is desired to follow the development of a microbe by uninterrupted observation for some hours or days, so that growth, fission, the formation and germination of its spores, etc., may be directly seen, the culture must be made in a "moist chamber," attention being given to the usual precautions, such as preliminary sterilization of the several parts of the chamber, rapid inoculation, etc. The chambers must be hermetically sealed by melting, using cement, or in some such manner, to prevent evaporation or infection. They must, therefore, be large enough to contain a sufficient quantity of air in addition to the necessary nutrient substance. Investigations of this sort are most frequently attended with some difficulty, especially for beginners, who can best practise them upon larger forms, such as yeasts and moulds, passing from these to the spore formation and germination of the large species of bacillus.

The following rules are observed in employing the various moist chambers, the most important and useful of which will be described.

Cover-glasses are cleansed in the usual manner with hydrochloric acid, followed by alcohol and finally by distilled water. After careful drying they are laid in a pair of small glass trays (Fig. 13) which are wrapped in paper and, with their contents, sterilized in the dry oven at 150° C. For further certainty, the cover-glasses may be drawn several times through the flame, immediately before use. In the same way, the different kinds of slides and chambers are sterilized by dry heat, wrapped in paper, in which they remain until the moment of use.

In preparing the moist chambers it is well to use a larger

piece of sterilized paper to unwrap the slides upon, and to cover them with small bell-glasses, leaving them uncovered only the shortest possible time. Cover-glasses must be ated with the same care. The larger shallow glass trays (Fig. 12) serve well as bell-glasses.

Several chambers are commonly employed at the same time, since some of them are liable to contamination while being prepared, even though they are sown quickly and carefully.

Cell-cultures are always started from young and strong cultures, usually in the same medium that is used in the moist chamber. Care is to be taken that the germs are uniformly distributed, and in proper nu , one to four in each field of the microscope being right. As this depends upon repeated preliminary examinations, thr test-tubes are used,

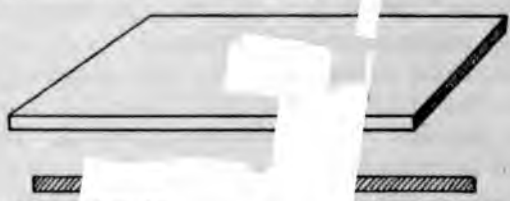

Fig. 57.—Hollow-g h Hanging Drops.

each containing a few grams of a suitable nutrient medium. A rather large number of germs are suspended in the first, and the effort is made by strong shaking to isolate them and distribute them uniformly. A drop is then transferred by means of a platinum loop to the second tube, and after thorough agitation the number of germs in the new mixture is determined under the microscope by examining a drop of it in the sort of moist chamber to be employed for the culture, and with the power to be used for this. If there are too many germs, a little fluid is added from the third test-tube, but if too few are present, their number is increased by adding a drop from the first tube.

One of the simplest and most frequently used moist chambers (in which Koch first observed the growth and spore formation of *Bacillus anthracis* outside of the animal organism, in 1876) is the hollow-ground slide—a glass slip of the form and size of an ordinary microscope slide, with a circular depression at the centre, about 15 mm. in diameter (Fig. 57).

After placing a small drop of culture-fluid, containing the microbe to be studied, on the lower side of a cover-glass, this is laid over the hollow and fastened to the slide in an air-tight manner by smearing with vaselin. Aside from the general rules given above, attention is to be given in the use of this cell, and in examination in hanging drops to the following: The drop must be spread out in as thin a layer as possible, because it must usually be capable of examination through its entire depth. Often it is well to place a drop of sterile nutrient fluid on the cover-glass, and to infect it at some easily recognized point along the margin of the drop.

It is best when the drop has been placed on the cover, to fix this to the slide by smearing a little vaselin around the depression with a sterile glass rod, after which the slide is lifted and turned over, and pressed against the cover-glass so that the edges of the latter are covered by the vaselin, while the culture drop projects into the hollow. Instead of fluid, a small quantity of nutrient gelatin may be placed on the lower side of the cover-glass, making a miniature plate-culture.

The preparation is first examined with a low power to get a notion of the germs present, and to find a place where they are especially well distributed, when the slide is fastened on the stage of the microscope and the germs that have been picked out are found with the higher power it is wished to use for the continuous observation. When a hanging drop is to be found and brought into focus under the microscope, this is greatly facilitated by the fact that moisture at once condenses upon the cover-glass about the drop, so as to give the cover a roughened appearance. By first finding this, and then moving the slide until it disappears, the margin of the drop is reached. Cultures of this sort can be kept on the stage of the microscope for days without suffering harm, and the development of a single germ can thus be followed, step by step.

If it is desired to hasten the process, or if the temperature of the room is too cold for the development of the bacteria, the moist chamber may be placed on some form of warm stage (such as Schultze's, Ranvier's, Israel's, or Vignal's), or the thermostat for the microscope, recommended by Panum (*Nord. Med. Arkiv*, 1874, VI., No. 7), may be used. Usually, however, it is sufficient to place the moist chamber in the brood-oven, removing it now and then for microscopic exam-

m: ı, care being taken to find the same part of the preparation each time. The simplest "finder" for marking a given point so that it can quickly be found again under the microscope, is that indicated by Hofmann, viz., scratching a cross on each side of the opening in the stage, one upright (+), the other oblique (×). When the point to be marked is centred in field, two crosses are marked in ink on the slide exactly ov... ...se on the stage.

...tcher's moist chamber (Fig. 58) consists of a deep ... fastened to a slide by a cement which is not injured ... to 150° C. for sterilization. The experimenter can ea... fasten the rings by one of the cements for mending ... ware; Hansen recommends for the same purpose a solu... of gelatin in glacial acetic acid, to which finely pulverized potassium bichromate is added just before use.

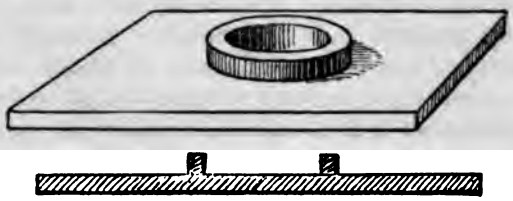

FIG. 58.—Boettcher's Moist Chamber.

A little sterilized water is placed in the bottom of the cell, and the upper edge of the ring is painted with vaselin to fasten the cover-glass. The chamber is used like the hollow-ground slide, either for examination in hanging drops, or for the observation of small plate-cultures in gelatin. The latter is the method used by E. Chr. Hansen in obtaining pure cultures of yeast for use in breweries, starting from a single cell. As a rule he employs rather large rings (about 25 mm. inside diameter), and round cover-glasses of corresponding size. A drop of nutrient gelatin containing the yeast is spread upon the latter, with all of the precautions indicated above ("Meddelelser fra Carlsberg Laboratoriet," ii., 152).

The use of hanging drops is attended with certain difficulties. The depth of the drop is relatively great, its lower surface is not plane, and the germs easily change position in it. These difficulties are partly avoided by the use of gelatin, which, nevertheless, can by no means entirely replace fluid

culture media because of its influence upon the movements and mode and rapidity of growth of bacteria. Brefeld's film-cultures, described below, avoid these, but are attended with others.

A simple means of remedying some of the defects of the hanging drop consists in covering the lower surface of the drop with a fragment of cover-glass, which adheres by capillary attraction, insuring a flat bottom to the fluid. The same end is reached by the use of Ranvier's moist chamber (Fig. 59), consisting of a slide with a deep groove ground in the centre, surrounding a circular disk the surface of which is about 0.1 mm. lower than the rest of the slide. The drop of fluid is placed upon this lower central part, vaselin is painted around the groove, and the cover-glass pressed down upon it. In this way the drop is hermetically inclosed between two

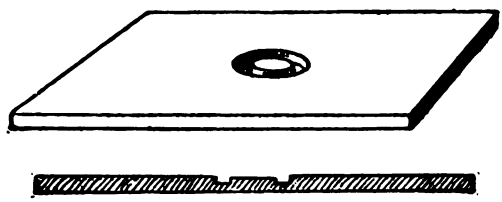

FIG. 59.—Ranvier's Moist Chamber.

parallel flat surfaces, while the groove serves as an air-chamber.

A very expensive and fragile, but otherwise excellent moist chamber, is the modification of De Bary's and Geissler's model used by Brefeld in his study of *Bacillus subtilis*, in which he succeeded in following the entire development from spore to vegetative cells and from these to new spores. This is a glass tube 20 cm. long (Fig. 60), in the middle of which a transversely cylindrical cell 2 mm. deep is blown, the flat top and bottom of which have the thickness of a cover-glass. To prepare it for use, it is thoroughly cleansed with hydrochloric acid, distilled water, alcohol, and ether, and each end of the tube is plugged with cotton. When dry it is sterilized at 150° C. The microbes to be studied are uniformly distributed in a suitable culture fluid, until by examining several drops spread very thinly, it is found that they are present in the right number (about one to four to each microscope field). One plug

is now removed, the open end is quickly flamed and immersed in the fluid, which is drawn into the cell by suction applied to the other plugged end of the tube. When the chamber is quite full, the fluid is allowed to run out again, the wet end of the tube is dried with sterilized filter-paper, and replugged, both ends are sealed with sealing wax, and the cell is ready for examination. The inside of the thin-walled chamber is here lined by a very thin film of fluid containing the germs, so thin that the bacteria do not move about in it. A suitable part of the preparation is found, and the chamber is fixed upon the stage of the microscope. In searching through it, which is done with the lowest power sufficient for recognizing the germs, care is taken not to crowd the objective against the thin and fragile wall of the cells, a mishap which is rendered all the easier by the fact that the latter is not perfectly flat. It is most easily fastened on the stage by first placing it upon a thin and well-cleansed slide, to which the cylindrical ends can be attached by paraffin. Admitting of the safe and easy transmission of gases, this moist chamber can also be used for studying the development of bacteria in different gases.

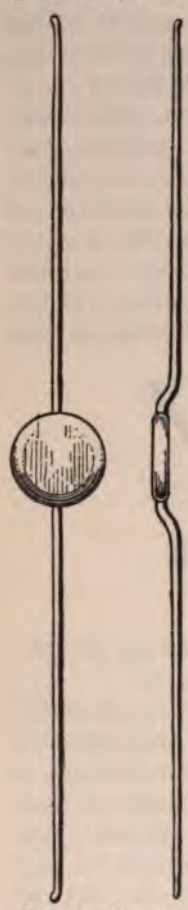

Fig. 60. — Geissler-chamber for Cultivation in a Film (Brefeld).

Other forms of moist chambers are easily improvised out of the material and appliances to be found in every laboratory. As it may be important at times to work with a very large number of cell-cultures at the same time, some of these easily extemporized forms deserve description.

Buchner studied the germination of spores of *Bacillus anthracis* in a moist chamber such as is shown in Figure 61. A very small quantity of a pure culture containing only the spores of this species is dried upon a cover-glass, and a small drop of culture-fluid added. The cover is then supported on a slide at two edges, by fragments of cover-glass, the entire margin sealed with some cement, and the slide placed on a warm stage.

A cell, the inventor of which is not known to me, consists of rather thick pasteboard (No. 16), cut into the form shown in Figure 62, and carefully sterilized by boiling or in the steam cylinder, which is best effected by piling several pieces up between a couple of microscope slides and tying them firmly together. One of the pieces of pasteboard, while still wet from sterilization, is laid on a sterile slide and pressed into contact by a glass rod. A cover-glass, with the hanging drop, is laid over the hole in the pasteboard and carefully pressed down on it, after which sterile water is added at one edge until the paper refuses to absorb more. In this simple chamber, the paper serves both as a source of moisture and a means of attaching the cover, so that it must be kept from drying out as long as the chamber is in use; consequently, when not undergoing examination, cells of this kind, like plate-cultures, need

FIGS. 61 and 62.—Improvised Moist Chambers. 61, Buchner's form; 62, Cardboard for Cell.

to be kept in a large moist chamber (*cf.* p. 499), and from time to time the pasteboard must be resaturated by the addition to the outer edge of a little sterile water or very dilute sublimate solution. For this reason this form of cell is not well adapted to continuous observation under the microscope for a period of days, though it may often prove very useful as an accessory. Other materials may also be used for the preparation of moist chambers of the same sort.

In his studies of the life-history of the higher fungi, Brefeld has cultivated them under control of the microscope by the simple use of slides upon which a nutrient fluid was spread in a thin layer. These plate-cultures in fluid are not suited to the study of bacteria. So far as yeasts are concerned, they offer no especial advantage over cell-cultures, but are attended by certain disadvantages. On the other hand, they are of the greatest importance for the study of the development of higher fungi, and for this reason merit brief consideration here.

The solutions described on pages 458, 459 are used, generally after being boiled down so that they are not too fluid. By means of a glass rod, an elongated drop is placed on a sterile slide, and enough of the spores to be studied are added and distributed with a platinum needle so that only one or two occur in each field of the microscope. It is evident that such cultures cannot be used for prolonged uninterrupted observation. If kept long upon the stage of the microscope, they will be ruined by drying out or contamination. Between the different examinations, they must be kept in larger moist chambers, the air of which is always saturated with moisture (a common flat porcelain platter filled with water and covered by a bell-glass dipping into the water), and they can scarcely be used successfully except in laboratories where the air is kept as free as possible, by great care, from germs, and especially moulds; but Brefeld's works show sufficiently how far it is possible to utilize this method. Besides other advantages over similar slide-cultures on solid media, these admit of transplanting the spores after germination has begun, more favorable conditions are given the moulds for growth and development, and it is possible to renew the supply of food material during weeks or even months, as it becomes exhausted, by adding a fresh drop of culture-fluid at the margin every day or two.

CHAPTER X.

INOCULATION OF ANIMALS.

We come now to a group of experiments to which, in a certain sense, all of the preceding chapters point—experiments calculated to give the proof that a large number of the most familiar contagious diseases are induced by bacteria, and to render possible a more intimate study of the mutual relations between these bacteria and the animal organism. In this connection it must be said that conclusive proof that a given infectious disease is due to a specific bacterian form, is given only when such a form, well characterized morphologically, chemically, or physiologically, can always be demonstrated in the organs by the microscope and by cultures, in this disease and only in it; and when, further, these bacteria, after being cultivated pure for several generations outside the animal organism, when reintroduced into an animal of the species they were originally obtained from, produce the same disease in this, and are then demonstrable in its tissues under the microscope and by pure cultures.

Various kinds of animals have been used for experiment, but usually the smaller rodents (rabbits, Guinea-pigs, rats, and mice), or birds (fowls and pigeons) are employed. It is now well known that inoculations, not of one but of a large series of infectious diseases, may be effected upon one of the most accessible, cheapest, smallest, and most prolific of mammals—the white mouse, which is more or less receptive for splenic fever, chicken-cholera, malignant œdema, several forms of septicæmia, some pyæmic affections, glanders, tetanus, etc., etc. While the white mouse (an albino of the house mouse, *Mus musculus*) is very slightly receptive for glanders, according to Loeffler, the European field mouse (*Arvicola arvolis*) is very susceptible to it (Loeffler), as is also the wood mouse (*Mus sylvaticus*) according to Kitt. On the other

hand, the field mouse is not receptive for mouse septicæmia, to which the white mouse shows a great susceptibility (Koch). Both field and wood mice are easily kept in captivity if fed upon oats and moistened bread. The wood mouse is very active, and its bite quite painful; and it is not advisable to keep several individuals of either of these mice in the same jar after inoculation, because in case one dies the others devour it at once. Where it is only desired to perform the most im-
rtant fundamental experiments in bacterial infection, it is,
refore, usually sufficient to employ white mice.

eping Mice.—After many trials, I can highly recom-
nd the use of the cracker-boxes spoken of on p. 441, as cages
mice. A large number of holes about as large as a half
e are made in the cover, *e.g.*, nine rows, of nine each. In
the holes are not large or numerous enough, evaporation

FIG. 63.—Mouse-jar.

from the interior of the box is checked too much, and the mice cannot stand the resulting humidity. The box is filled nearly half full of sawdust, a little cotton is laid on this, and the cage is ready for use. The mice are fed upon white bread softened with water and oats. The sawdust contributes largely to lessening offensive odors, and, in connection with the cotton, grain-hulls, and the excrement of the animals, forms a warm, soft, and dry mass, in which the mice tunnel, and thrive and breed well. Ten or fifteen adult mice can easily be kept in such a box, or a still larger number of young ones. Emptying the box and renewing the sawdust and cotton is only necessary once a month or even once in two or three months, depending upon the number of animals kept in it.

For isolating infected mice, it is best to use common glass pickle-jars, holding two quarts (Fig. 63). These jars are readily disinfected after use, and the animals can be easily observed in them. Each is filled for a third of its depth with sawdust, and covered at top by a square piece of close iron gauze, large and flexible enough so that it can easily be slipped over the mouth of the jar and pinched into the groove *a*. For greater security a heavy object may be laid upon the lid. In this way it is fastened securely enough so that an animal cannot lift it and escape, while it is readily taken off and replaced, and can be disinfected in the flame without difficulty.

When white mice are constantly used for inoculation, they are usually raised in the laboratory. Starting their propagation is not always easy, since mice are quarrelsome, and males which have not been raised together often fight and injure one another, while they are also apt to kill and eat the young. As a general thing, a few pairs are taken for a beginning, and kept apart. When a female is near the term of pregnancy, she is removed from the male and kept in one of the mouse-jars just described, where she remains with her young ones until their eyes are open, when they are all removed to one of the large cages, in which two females and their litters can be safely kept, as a rule, provided the young are of about the same age. The young mice which grow up together in this way generally get along so well that it is unnecessary to remove the pregnant females as long as there is room for their burrows and young.

The mode of inoculating an animal, and the point at which this is done, depend upon the object in view. If it is merely desired to infect the animal, introducing the contagium through a wound in the skin suffices in many cases. Not infrequently, however, it is wished to imitate the natural infection through the uninjured mucous membrane of the respiratory or digestive system. In other cases it may be necessary to introduce the virus under the dura mater, by trephining. In short, the most different organs and parts of organs are used for the introduction of cultures of bacteria, or infectious material. Only the most important of the methods of inoculation are considered in the following pages.

In most cases the inoculation of an animal is practically painless, so that it is anæsthetized only when some larger operation is involved, as in trephining for inoculation with rabies. Mice and rats are placed under a bell-glass with a wad of cotton moistened with ether, until, after a short period of excitement, they succumb to the anæsthetic. After they are removed from the bell-glass, and tied, insensibility is easily kept up, as they are very tolerant of ether. It is otherwise with Guinea-pigs and rabbits, the latter, especially, dying easily when anæsthetized with ether, or, particularly, chloroform. Practice, however, enables the operator to lessen the number of deaths from this cause, and in the Pasteur Institute only one to two per cent of the rabbits die from the an-

esthetic, which is administered by pouring a teaspoonful of oroform over a piece of absorbent paper folded as if for a er, which is then held like a cornucopia over the nose of the imal. After a few seconds the respiratory movements stop, l when they are resumed shortly afterward, insensibility as ile is complete, as soon as this occurs the administration of chloroform is discontinued.

Cutaneous inoculation is best performed on mice by abrading ear with a vaccine point dipped in the virus, although effected anywhere on the body after removing the Scarification of the skin followed by rubbing the virus or simply rubbing the latter into the uninjured skin, may be practised.

ubcutaneous inoculation of mice is best performed under skin of the back, just above the root of the tail. The ise being in a glass jar (Fig. 63), its tail is seized between umb and forefinger of the left hand and drawn out over m of the glass, while the body hangs into the jar, which vered with a small piece of board, held in place by the ingers of the left hand, so that there is just room for the ge of the root of the tail between it and the edge of the jar. [When the usual cylindrical jars of the German laboratories, with covers similar to those of candy-jars, but the top replaced by coarse iron netting and weighted, are used, these covers need only be tilted a little at one side to serve the same purpose. If gray house-mice are used, they are apt to be far more active than white mice, and it is best to quiet them by holding a handkerchief, moistened with a few drops of ether, over the cover, without carrying the etherization to the surgical point. In any such operations, the long "mouse-tongs" of the German dealers are a great convenience for first seizing the tail of an animal.—W. T.] The hair just above the tail is clipped off, and by means of a lancet-needle or a pair of scissors a small opening is made in the skin and a pocket torn in the subcutaneous connective tissue, into which the infectious material is placed. Solid bodies are introduced by means of the forceps; very small quantities of cultures, etc., by the lancet-needle or platinum needle; and slightly greater quantities of fluid, by means of capillary tubes or Pasteur pipettes.

When a considerable amount of fluid is to be injected into the subcutaneous tissue, a sterilized Pravaz syringe must be

used. The common Pravaz syringe is not adapted to sterilization at high temperature, since the piston is packed with leather, and the tip cemented on. Generally, a syringe is used the tip of which screws on to a thread on the glass cylinder, and with an elder-pith plunger, so that it may be sterilized by either moist or dry heat (Straus and Collin).

Material from cultures in fluid or from vigorous cultures upon solid media, can easily be taken from test-tubes by the pipette or platinum loop. But when the bacteria to be used for inoculation grow in a narrow line along the needle-thrust in a test-tube, and it is desirable to have a relatively large quantity of material, one should rather cut out the entire colony and use it either with or without melting. The process is a little different according as the culture is in gelatin, agar, or serum.

A gelatin culture is dipped in warm water or warmed over the flame until the outer part melts and the gelatin cylinder becomes free from the test-tube, so that it can be shaken down against the cotton plug, when the latter is carefully removed and the gelatin allowed to fall into a sterilized watch-glass, where, with a sterile and slightly warmed knife, all of the peripheral part containing no bacteria is cut off and removed, leaving only a small prismatic piece of gelatin containing the colonies.

Agar-agar, which neither adheres to the glass so firmly as gelatin, nor melts at so low a temperature, is removed in a somewhat different manner. The test-tube is warmed somewhat, a Pasteur pipette is passed to the bottom of the tube, between it and the agar, and by a strong puff through the pipette, the entire culture can usually be blown out of the glass. If this does not succeed, a warmed glass rod, such as the handle of a platinum needle, is passed down to the bottom through the agar at one side, so as not to come in contact with the colonies of bacteria. As soon as it has cooled, it can be used to draw the agar out by a series of pushes and pulls. The agar being removed into a sterilized watch-glass, it is treated just like gelatin.

Serum is far harder to manipulate, because it adheres to the glass and cannot be removed by melting, so that it is necessary to cut the colonies out of the test-tube as well as possible with a long-handled pointed knife.

Intravenous injection cannot be resorted to with mice, because of their small size. In the case of larger animals, it can generally be effected without exposing the vein by simply thrusting the needle of the syringe through the skin into the cavity of the vessel.

With rabbits, it is particularly easy to inject material into the veins of the ear and leg. For the former, the rabbit is wrapped tightly and carefully in a long towel, so that only the head projects. The ear is washed with 2-per-cent carbolic acid, partly to disinfect it, and partly because the vessels are more easily seen when the hair is wet. An assistant holds the animal's head and compresses the base of the ear, so that the

FIG. 64.—Injection of Culture into the Vein of a Rabbit's Ear.

veins swell, the ear is seized between the thumb and forefinger of the left hand so that it is slightly tense over the side of the forefinger, and the canula is carefully thrust through the skin into the vein (Fig. 64). The assistant now releases the end of the vein, the operator holds the canula still in the vein with his forefinger and thumb, and injects the fluid slowly. Bleeding is easily stopped by brief compression, or by amadou. In case the vein has not been pierced, the fluid soon begins to distend the surrounding connective tissue, when it is almost always useless to withdraw the canula a little way and make another effort to force it into the vein, but another vein is usually at once chosen for injection. Commonly the branch of the vein running along the posterior edge of the ear is selected, but there are many other available points on the ear.

When the ear is used for injection, there is the further advantage that one may be sure of really intravenous inoculation without attendant accidental inoculation of the wound, by simply removing the portion through which the injection was made, by a quick clip.

By connecting the needle-shaped canula with a larger syringe by a rubber tube, large quantities of fluid may be introduced into the veins of the animal, in the same simple and painless manner. As the injection must be effected very slowly, and in this case requires a longer time, it is best to fasten the animal upon a "rabbit-board" (the French model, used in Marey's laboratory, is far preferable to Czermak's) so that a sudden movement of its head shall not displace the canula.

For injection into the leg veins, the rabbit is firmly and carefully wrapped in a long towel so that only one hind leg is left free, the animal being allowed to draw the other up under its body. An assistant sits with the rabbit upon his lap, one hand extending the free leg firmly, while with the other he grasps and compresses the thigh a little above the knee-joint, so as to cause the veins to swell, his fore-arm resting upon the body of the animal. One of the subcutaneous veins in the lower joint of the leg is found, the hair over it is clipped off, the skin washed with 2-per-cent carbolic acid, and while the leg is further steadied by the left hand, the canula is pushed through the skin into the vein, where it is held by the pressure of the left thumb.

Intraperitoneal inoculation is most conveniently effected with a sterilized Pravaz syringe. The entire thickness of the abdominal wall is pinched up in a longitudinal fold, through which the canula is forced crosswise so as to emerge on the other side. On releasing the fold, the canula is carefully withdrawn enough, so that its point lies within the body cavity, while there is no danger of injuring the intestines.

In case large quantities of fluid are to be injected into the peritoneal cavity, a graduated glass pipette may be used, one end of which is plugged with cotton, while the other is connected by rubber tubing with a canula similar to that of the Pravaz syringe. The canula is inserted in the manner indicated, and the fluid blown in. The same kind of inoculation can also be effected with a Pasteur pipette, the perforation

being made with a lancet-needle, beside which, as a guide, the pipette is passed into the abdominal cavity. Mice and rats are best etherized before inoculation.

Inoculation in the peritoneal cavity is especially important in admitting of the introduction of very considerable quantities of either fluid or solid substances into the animal. In the latter case the body-cavity must be opened for a greater distance along the linea alba. By such laparotomy, carefully performed, an entire organ from a larger diseased animal may easily be inserted into a smaller one, *e.g.*, the heart and kidneys of a rabbit, into a rat.

Inoculation into the anterior chamber of the eye acquired special importance in the study of tuberculosis, since by inserting small masses of tuberculous material into the eye Cohnheim and Salomonsen succeeded in inducing tubercle of the iris, by which it became possible to directly observe the incubation period of miliary tuberculosis, and its independence of a preceding suppurative process. It has also recently been used for rabies inoculations.

The operation is performed by fastening the rabbit, on its belly, usually on an operating board, where its head can be perfectly fixed. An assistant opens the eyelids, most conveniently by sitting so as to face the operator, grasping the animal's head with both hands. Occasionally the nictitating membrane is so large that it must be held back. With a pair of forceps, a fold of the conjunctiva is seized, and with a suitable knife a cut 2 to 3 mm. long is made in the cornea, near its margin, with the usual precautions observed in ophthalmological operations. If the material to be introduced is a solid substance, it is passed through the opening by means of slender curved forceps, usually with very fine smooth points opening parallel, and by carefully stroking the cornea with a Daviel's spoon, the effort is made to crowd the introduced material into the bottom of the anterior chamber. If this is not easily effected, it is allowed to remain where it lies. Fluids are injected through a (usually) blunt and bent canula, inserted into the cut. To anæsthetize the eye for the operation, a 2-per-cent cocaine solution is dropped into it, the maximum action being reached after fifteen minutes (Howe).

Another place, easily accessible for observation, which has often been used for inoculations, is the cornea, in which the

conditions are very favorable for observing the effect of bacteria upon the connective-tissue cells. By means of a blunt needle, a large number of pricks or scratches are made in the corneal tissue, without perforating it, and the bacteria are gently rubbed into the wounds; or the needle may first be dipped into the virulent material,—but the first method seems to give surer results.

Inoculation beneath the arachnoid, as first used in hydrophobia infections in Pasteur's laboratory (Pasteur and Roux), is effected on rabbits and guinea-pigs in the following manner: A cut is made through skin and aponeurosis, on the crest between the eyes and ears, and the edges of the wound are held apart by a small tenaculum. The trephine (about 5 to 6 mm. in diameter) is applied behind the orbit, on one side of the middle line. When the circular groove in the bone is deep enough, the centre pin is withdrawn so that it shall not injure the dura mater. As a general thing, the fact that the bone is cut through, is observed in time, but for greater certainty it may be seen from time to time whether the disk of bone cannot be lifted out. When the dura mater is exposed, it is pierced with a needle-shaped Pravaz canula, bent nearly at right angles, which is drawn slightly toward the operator to avoid injury to the underlying brain, and two or three drops of the diseased spinal cord infusion are injected. The wound is cleansed with 2-per-cent carbolic acid and closed by a couple of sutures. In the case of dogs, the skin is pushed aside after the cut is made, the temporal muscle is loosened, and the skull is trepanned in the fossa temporalis, where the skull is thinner, and there is little bleeding.

As compared with all other methods employed in the study of rabies, inoculation under the dura mater has the advantage of giving absolutely certain infection, as well as the shortest and constant incubation. But according to the latest investigations of Roux and others, the far simpler inoculation in the anterior chamber of the eye gives as certain infection as the subdural.

Pure virus is always found in the medulla, etc., of animals dead of hydrophobia, which is best suspended in sterile bouillon or 0.7 per cent salt solution, and injected with a Pravaz syringe. The removal and preparation of the material must naturally be effected with the greatest possible cleanliness, to

avoid accidental infection. In the Pasteur Institute the material for inoculation is prepared by snipping out a small piece of brain substance from the bottom of the fourth ventricle and placing it in a wine glass holding about 150 cm., which has been covered with paper and sterilized at 150° C. Here it is rubbed to a soft paste by means of a glass rod, and a small quantity of sterile bouillon is gradually added, while it is constantly stirred. The glass is then covered with paper and set aside until the coarser particles have fallen to the bottom, the upper, slightly turbid, layer of fluid being used for injection.

The medulla oblongata retains its virulence unchanged for at least a month when kept in pure neutral glycerin—a fact which should be remembered whenever the occasion arises for sending parts of the central nervous system of man or one of the lower animals to a distant laboratory for diagnosis.

Rabies vaccines are prepared as follows (Pasteur and Roux): A rabbit weighing two kilos and measuring about 45 to 50 cm. from the nose to the root of the tail, is inoculated by trepanning with "virus fixe." Six or seven days later it shows symptoms of rabies, and dies on the tenth day. Before putrefaction sets in, the central nerve system is removed as follows: The skin is split down the back from nose to tail, dissected to one side, the dorsal and cervical muscles are loosened from the spinal column and cranium, and the spinous processes are removed by bent shears. The nose is then seized with a pair of strong bone nippers, and so held fast with the left hand, while the theca cranii is snipped and broken off by means of a pair of Liston's bone scissors. Then the vertebral arches are removed one by one, by snipping them through on the right and left side, as near the body as possible, without injuring the spinal cord, and breaking them off. This is more easily described than done, for the spinal cord is easily crushed, especially in the cervical region; but with practice one gradually learns to expose it for its entire length without injuring it with the coarse instrument used. Then the cord is cut off over the cauda equina, its membrane is seized with forceps just above the cut and it is raised for a distance of 6 to 7 cm., and all adhesions are cut. The loosened piece is cut off, a sterile silk thread tied about one end, and hung up (Fig. 65) in a litre flask with two openings previously plugged with cotton and sterilized at 150° C. Enough caustic soda to cover

the bottom is dropped into the flask, the spinal cord is hung from its neck, and the whole set aside at 20 to 25° C. The vaccines are prepared in the manner described above, from such pieces of spinal marrow, hung up and dried for a longer or shorter time.

Fig. 65.—Drying-jar for Hydrophobia Vaccine.

Infection through the digestive tract is effected by carefully mingling the contagium with some food that the animal is fond of, which is given it in not too large quantity, the animal being previously kept without food for a day or less, if necessary. In case of mice and other small animals, this is the only available method. In the case of larger mammals (rabbits and Guinea pigs), simple feeding is also used when large quantities of solid material are to be introduced into the stomach, and it is the best means of inducing infection through the alimentary canal, because it is in this way that natural infection by means of food occurs as a rule. Still it cannot always be employed, and other means must then be resorted to. Fluids (*e.g.*, cultures of bacteria) can likewise be poured or injected through the œsophagus, the rabbit being wrapped in a towel with the exception of its head, and held on the lap of an assistant. The animal is made to open its mouth by slight pressure upon its cheeks over the molar teeth, and a small wooden gag (Fig. 66) is inserted so that its incisors rest in the grooves on the upper and lower surfaces (*b*). Through the perforation in the gag, a No. 17 catheter can easily be introduced into the rabbit's ventricle. Adhering bits of food show that it has been inserted right. In case of the Guinea pig, a smaller catheter (usually a bulb catheter) must be employed, and it requires to be passed down with especial caution.

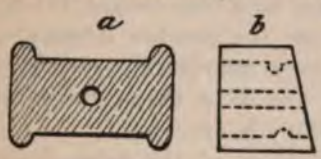

Fig. 66.—Wooden Gag for Passing a Catheter into the Stomach, in Feeding Experiments. *b*, Section of same.

Solids are quickly introduced into the crop of doves or fowls by opening the beak, and placing the food in the mouth, as far back on the tongue as possible, when the bird quickly swallows it. Small meal pellets are formed with cultures and other fluids containing bacteria, and these are introduced in the same way.

The introduction of infectious fluids into the stomach and intestine through the abdominal wall, by means of a Pravaz syringe, is more certain and reliable. If the contagium is to be introduced directly into the intestine, the abdomen must be antiseptically opened, a fold of the intestine found and carefully fixed, and the canula thrust through its wall. In this way cultures of the cholera spirillum are injected into the duodenum (Nicati and Rietsch), so that they do not pass through the stomach, and the action of the gastric juice upon the microbes is avoided.

Pathogenic bacteria can be brought in contact with the intact surface of the lungs by injection through an opening made in the trachea. For the sake of entire certainty that the virus is not at the same time introduced through the open wound, this may first be allowed to heal, leaving a small tracheal fistula. In the case of large animals, Arloing, Cornevin, and Thomas have reached the same end by passing a drainage tube through a metal canula, and injecting the desired material through the former, in small quantities, so as to avoid spasms of coughing.

If the natural means of infection through the mucous membrane of the respiratory organs are to be imitated as closely as possible, the bacteria must be very finely and uniformly suspended in the air inhaled by the animal, so as not to cause mechanical irritation. This is best effected by use of a spray or dry powder. The former method is open to the objection that the spray contains not only extremely fine drops, but likewise some which are a little larger, so that the mucous membrane of the nose, or the entire animal, becomes quite damp. To avoid this, Buckner joins the atomizer to a two-necked Woulf flask holding about three litres, where the coarser drops are allowed to settle, while the finer, as a nearly imperceptible mist, are passed out of one neck of the flask through a tube to the inclosed chamber where the animals are.

For the second method, a fluid-culture of the bacteria is poured over a rather large quantity of spores of *Lycoperdon giganteum*, which are then dried off over calcium chloride, and the powder is blown into the closed animal cage by the bellows (Buckner). In his experiments on the entrance of spores of *B. anthracis* through the lungs, Buckner used 0.25 gm. of powder for a space of three litres, and allowed the in-

halation to continue ten to fifteen minutes. Other powders (carbon, talc, etc.) can also be used as a vehicle for cultures of bacteria, but the puff-ball spores are superior to all of these in being very small, uniform, and of low specific gravity. In case the bacteria are killed or deprived of their virulence by drying, this method, of course, cannot be employed.

In such experiments, the animals must be untrammeled so that their respiratory movements are not checked or altered, and it is best, therefore, to let them remain unfastened. A number of mice can be placed together loose in a tight tin box with a few breathing holes plugged with cotton. If it is necessary to fasten the animals so as to keep their heads in a given direction, wire gauze can be used, as it may be bent and shaped at will. A single mouse can conveniently be placed in a glass tube 3 to 4 cm. in diameter, with a bored and split cork in one end, which serves to hold its tail.

When inhalation experiments are performed with bacteria that are pathogenic for man, the operator should remember to take sufficient precautions, such as having tight vessels and tubes, cotton-plugged air-spaces about the cages of the animals, and long tubes for the atomizer, and the work should be done in the open air.

CHAPTER XI.

CULTURES FROM MAN AND ANIMALS. COLLECTING AND PREPARING PRIMARILY STERILE CULTURE-MEDIA.

In attempting to obtain cultures of the pathogenic microorganism from the blood or organs of an animal which has died from an infectious disease, the rules given in Chapters I. to III., and V., are to be observed, as well as the following:

Since the more or less dirty hair or feathers of the animal contain a possible source of contamination, it is best to skin or pluck the body before opening it. All of the parts covered by hair may also be washed with sublimate solution, or covered with filter-paper wet with sublimate.

All instruments used for preparing the body must be carefully sterilized. Since repeatedly heating them to a high degree in the flame works destructively upon knives, scissors, and forceps, it is best to have two sets of these instruments; one intended for the coarser part of the work, sterilized by flaming, and commonly used so hot as to cause the flesh to hiss while the cut is being made; the other for finer operations, first sterilized at 150° C., in a metal case or wrapped in paper, and merely hastily flamed just before use.

In addition to the gas or spirit flame, a dish of 0.1 per cent sublimate solution, and of 5-per-cent carbolic acid, must be kept ready for the disinfection of hands and instruments. To avoid contamination from contact, the sterilized instruments are laid upon glass supports (Fig. 18) and covered with a bell-glass, or dropped into a short cylindrical vessel with their points projecting out at top.

While exposing the organs from which material is to be taken for cultures, use is made of strongly heated instruments, which, as far as possible, are kept from touching the organs. No definite rules can be given, further than this:

If a culture is to be started from fluid contained in a cavity,

it is best to singe the surface over, before piercing the wall. For example, if a collection of fluid in the pleural cavity is to be used, after exposing the ribs and intercostal muscles in the usual way, a part of one of the intercostal spaces is scorched by means of a glass rod heated in the flame, and then, with a glowed needle or strongly heated small knife, the pleural cavity is opened, and the small gaping wound made for inserting the inoculation-needle, capillary tube, or pipette, according to the quantity of fluid needed. In the same manner, blood is obtained from one of the anterior chambers of the heart. After cauterizing the surface, as a rule the capillary tube or pipette may be thrust through the thin wall, without the previous use of a knife, which only becomes necessary when a thin and flexible platinum needle is to be inserted.

To obtain material from the substance of a solid organ, one of the thicker and more rigid needles is used. The organ may be snipped in two with scissors carefully flamed or even glowed, and the needle thrust into its substance from the uncontaminated cut surface, or it may be torn open with sterile fingers or forceps, and in this way a surface exposed which has not been touched at all by the instruments. [Loeffler advises that when parts of cut organs are to be broken in this way, the surface be first disinfected by dropping the whole piece into 0.1 per cent sublimate, and moving it about in this for a minute or two]. By using flamed, but not too strongly heated, curved scissors, small pieces of the organ may be snipped out and placed on or in the culture medium, at least after being crushed between two sterilized glass slides. This method is recommended by Koch in sowing from tubercle.

Since the white mouse is the animal presumably used in the elementary inoculation experiments, the following description is given of the best means of obtaining cultures from its heart blood. As soon as the external examination is complete—especially about the inoculation wound—the body is extended upon its back by a shawl pin through each leg, on a small board, which it is well to first cover with a sheet of paraffined paper over which a couple of sheets of filter-paper are laid to absorb blood, etc. The head is finally fixed by means of a fifth pin through the nose. The skin is dissected away from the ventral surface as far as possible, and entirely cut off, the occasion being taken to examine the axillary and in-

tics, and, if necessary, to obtain blood from the s for microscopic investigation. Seizing the iform process with a pair of sterilized forceps, ilted strongly, and by means of flamed sharp-pointed ors, one end of which is inserted under the ribs, a suffi- t part of the thoracic wall is removed to expose the peri- rdium. In this way the intestines are not approached, and instruments are not exposed to infection from this dan- erous source. Care is taken to avoid touching the anterior ace of the heart with the scissors. With two pairs of mall flamed forceps the pericardium is now torn open, and a cut is made into the exposed heart. Usually sufficient to wet the platinum needle at once bubbles out of the ; otherwise the needle is pushed through the opening, e culture started from the fluid obtained. The dissec- s now completed in the usual way, but with especial care cleanliness so as to avoid rendering it difficult or impossi- to make cultures from other organs in which morbid nges may subsequently be discovered. When the dissec- is finished, and the necessa / preparations have been ed, the cadaver is wrapped in t e filter-paper it lies on, and ned up.

The manner of making the dissection naturally varies with he organ chosen for starting a culture, the rule being to proceed directly to the organ from which the chief culture is to be made. If, for instance, it is especially important to obtain a culture from the pulp of the spleen, the mouse is laid on its side with the spleen up, so that it can be exposed without disturbing the other organs too much.

The directions and examples given here may serve as a sufficient introduction to the methods of obtaining cultures from the dead body, as well as to the collection and similar use of fluids and tissues from the living body, where, however, consideration for the patient may necessitate many modifications: *e.g.*, scarification with the heated glass rod must be replaced by a thorough cleansing with disinfectants, the Pasteur pipette must give place to the sterilized Pravaz syringe, etc.

Few appliances are needled for starting such cultures with all requisite precautions, even at the sick-bed or operating table, or for collecting the morbid products in a state of complete purity, for further elaboration in the laboratory. Even

when much is aimed at, practically all that is needed is the usual disinfectants (carbolic acid and corrosive sublimate); a little sterile absorbent cotton and filter-paper; scissors, knife, and forceps, wrapped in paper and sterilized at 140° C.; sterilized Pravaz (or Straus) syringe; alcohol lamp; platinum wire; capillary tubes; Pasteur pipettes and others with a capillary constriction (Fig. 53, *a*); small test-tubes containing various culture media, some of them for the culture of anaerobic forms, *e.g.*, with a considerable depth of nutrient gelatin; labels; and cover-glasses. Some of these can be prepared on short notice in the sick-room, some are only needed for exceptional use, while the rest should always be kept in the hospital wards to prevent the waste of much valuable material.

The collection of primarily sterile culture-media, which should really have been considered in the third chapter, is treated here, because the precautions to be observed are exactly the same as in obtaining cultures from the dead body, the collecting apparatus only being different. Usually it is desired to collect the sterile fluids (blood, urine, milk, etc.) either in rather large vessels from which they can be transferred to a number of smaller culture-glasses, or they are at once drawn into the latter.

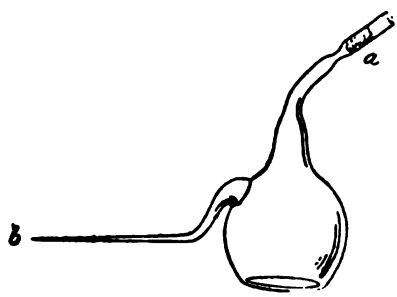

FIG. 67.—A Pasteur Wash-bottle.

In the first case, the so-called Pasteur wash-bottle (Fig. 67) is best used. As the Figure shows, this is really only a very large Pasteur pipette, with a reservoir of peculiar form. When the capillary point *b* has been sealed by fusion, and a cotton plug inserted at *a*, it is sterilized at 150° C. Just before use, the tip *b* is broken off, and the entire capillary part is flamed. Observing the precautions indicated above, the point is inserted, and the receiver sucked full, after which the point *b* is again fused. As soon as possible afterward, the sterile fluid is transferred to smaller culture-vessels, by blowing through *a*, after once more breaking the point off and inverting the reservoir. The test-tubes or Chamberland flasks which have been filled in this way are kept on probation at

to 40° C., for several days before being used. In this way is possible, for instance, to collect large quantities of sterile from the newly slaughtered animals at any slaughter-e, by passing the capillary tip of the flask through the of the bladder, after the abdominal cavity is opened.

ccasionally it may be convenient to collect the fluid at in smaller culture vessels. For example, if sterile blood be taken from the heart of a newly killed animal, it would ite in the larger vessel before it could be transferred smaller ones. In such cases, Pasteur pipettes may be not closed with simple cotto plugs, as is usual, but with r tubes plugged with cotto (Fig. 68), which can be re-ed and again replaced with far less danger of contamina-when the contents of the tube are to be inoculated. The f the pipette is opened, flamed, and inserted into the heart ewly killed healthy animal, the tube sucked full of blood, more hermetically sealed below, and set aside some time

Fig. 68.—Pasteur pipet h number Cap Plugged with Cotton.

for observation, after which, if free from germs, it may be used directly as a culture vessel. In the same manner, fresh white of egg, containing no germs, can be collected from hens' eggs (*cf.* p. 472).

The collection of sterile fluids from living men or other animals is not always as easy or certain as in these cases, though it is by no means impossible.

For the means of obtaining sterile blood by phlebotomy, see p. 470. Milk can be drawn into sterile test-tubes, after a very thorough cleansing of the surface of udder and teats; but one should expect to find a portion of the tubes accidentally contaminated. Urine can be obtained in a sterile condition either by passing it directly into sterile vessels or drawing it with a catheter, after a careful disinfection of the urethra by washing it out several times.

Now and then very good opportunities occur for the collection of a large quantity of sterile culture fluid from living patients. Dropsical and other similar fluids can be collected free from germs without great difficulty. For this purpose,

a small Southey trocar is used, and the fluid is collected in a large flask furnished with a rubber stopper bored with two holes, one of which is plugged with cotton, while the other admits a short glass tube which is joined by rubber tubing to the trocar. The instrument and glass ware are sterilized at 140° C., while the rubber tubing and stopper are steamed before use.

The rules for preparing primarily sterile infusions are implied in the preceding. Meat infusion, for instance, is obtained by cutting a piece of muscle from a recently slaughtered animal, as rapidly as possible, and with all care, and dropping it into sterilized water. Vegetable infusions are generally more easily prepared, if rather large organs, such as fleshy roots and tubers, are employed. The surface of these is cleansed with sublimate solution, after which prismatic pieces are rapidly cut from the interior with a knife that has been heated in the flame so that it hisses with each cut. From the nature of the case, rules for each particular instance cannot be given, often it is necessary to specially prepare the substance, *e.g.*, in forming the primarily sterile infusion of jequirity as described by Salomonsen and Christmas ("Hosp. Tid.," 1884).

It is always to be expected that a certain number of the fluids and infusions prepared in the ways indicated above have become accidentally contaminated in the process of preparation; hence they must never be made use of until they have been kept several days in the thermostat at about 35° C., remaining completely clear and unchanged.

CHAPTER XII.

DISINFECTION EXPERIMENTS.

WHEN it is desired to learn whether a disinfectant is capable of destroying a given contagium, the most natural way is to expose this particular germ, if it is known, or if not, substances which carry it, to the influence of the disinfectant, after which it is used for the inoculation of a suitable organism. But the difficulties in the way of such a test of disinfectants are evident. Often the contagium is one to which our experimental animals are not susceptible, and even when inoculations are possible, they are often too complicated to be feasible on a large scale. Hence, long before pathogenic bacteria could be isolated in cultures, putrefactive bacteria and other micro-organisms were employed as substitutes for the real contagia, in investigations concerning the efficacy of disinfectants, because of the resemblance of pathological processes to those of putrefaction and fermentation.

To-day, with greater reason, non-pathogenic bacteria can be employed as tests of the relative disinfecting power of various substances; for we now know that a large part of the contagia really are bacteria, and a better knowledge of the natural history of the latter has rendered possible the avoidance of numerous errors pertaining to earlier investigations and results. For instance, it is now known that a motile species is not to be regarded as dead because its motions cease; and the extremely different resisting power of different species, and the surprising vitality of spores, are now recognized, as well as the fact that conclusions cannot be drawn for bacteria in general, and hence for all contagia, from what is learned of casual mixtures of bacteria. *E.g.*, the bacillus of typhoid fever is very resistant toward carbolic acid, a circumstance which, according to Chantemesse and Vidal, facilitates their recognition in mixtures of bacteria, since they are

organisms of developing a nutrient gelatin which contains 5 per cent of carbolic acid. On the other hand, substances are to be found which are poisonous to a single species, while they are quite harmless for others: *e.g.*, quinoform, in the anti-bacterial influence of which hope was placed before the investigations of Lössing and Boyd. But while this substance is not fatal to the greater number of bacteria, such as *Micrococcus pyogenes aureus*, the anthrax bacillus Koch-Gaffky, and a number of other pathogenic germs either within the animal organism or in cultures, it is extraordinarily destructive to the cholera spirillum Koch-Gaffky.

Exact directions for experiments with disinfectants will be followed here very closely, since he has recently shown the greatest energy and given the simplest and best means of testing it. It is also well known that the researches of Koch, Gaffky, and Loeffler concerning many points have caused an entire revolution in the methods of disinfection.

The rules to be followed in testing the germicidal value of a disinfectant are briefly the following:

Pure cultures of well-known bacteria are used as reagents and mixtures of unknown composition. For a complete knowledge of the rank of the disinfectant, these pure cultures should represent the several groups of microorganisms which are active in disease and fermentation, *i.e.*, moulds, yeasts, and bacteria. Bacteria which do not form spores should also be represented, as well as the most resistant bacilli (*e.g.*, the hay bacillus, Chapter IV.). But if it is only desired to know whether a given substance is capable of destroying all organic life, and consequently all living contagia, it is sufficient to use bacillus spores alone, since these are the most resistant living beings known at the present time.

The forms chosen as reagents ought to be easily recognizable by macroscopic characters; consequently chromogenic species are preferable, such as the black *Aspergillus niger*, the pink yeast ["*Saccharomyces glutinis*"], the blood red *Micrococcus prodigiosus*, etc., etc. The persistence or absence of ability to develop after exposure to the action of the disinfectant is taken as evidence of their life or death.

According to the nature of the disinfectant, and the circumstances under which it is tested, the cultures employed as reagents are used in various ways. Sometimes they are not

CHAPTER XII.

DISINFECTION EXPERIMENTS.

When it is desired to learn whether a disinfectant is capable of destroying a given contagium, the most natural way is to expose this particular germ, if it is known, or if not, substances which carry it, to the influence of the disinfectant, after which it is used for the inoculation of a suitable organism. But the difficulties in the way of such a test of disinfectants are evident. Often the contagium is one to which our experimental animals are not susceptible, and even when inoculations are possible, they are often too complicated to be feasible on a large scale. Hence, long before pathogenic bacteria could be isolated in cultures, putrefactive bacteria and other micro-organisms were employed as substitutes for the real contagia, in investigations concerning the efficacy of disinfectants, because of the resemblance of pathological processes to those of putrefaction and fermentation.

To-day, with greater reason, non-pathogenic bacteria can be employed as tests of the relative disinfecting power of various substances; for we now know that a large part of the contagia really are bacteria, and a better knowledge of the natural history of the latter has rendered possible the avoidance of numerous errors pertaining to earlier investigations and results. For instance, it is now known that a motile species is not to be regarded as dead because its motions cease; and the extremely different resisting power of different species, and the surprising vitality of spores, are now recognized, as well as the fact that conclusions cannot be drawn for bacteria in general, and hence for all contagia, from what is learned of casual mixtures of bacteria. *E.g.*, the bacillus of typhoid fever is very resistant toward carbolic acid, a circumstance which, according to Chantemesse and Vidal, facilitates their recognition in mixtures of bacteria, since they are

capable of developing in nutrient gelatin which contains 0.2 per cent of carbolic acid. On the other hand, substances are to be found which are poisonous to a single species, while they are quite harmless for others: *e.g.*, iodoform, on the antibacterial influence of which, blind reliance was placed before the investigations of Rovsing and Heyn. But while this substance is not fatal to the greater number of bacteria, such as *Micrococcus pyogenes aureus*, the tubercle bacillus (Rovsing) and a number of other pathogenic forms, either within the animal organism or in cultures, it is extraordinarily destructive to the cholera spirillum (Buckner).

Koch's directions for experiments with disinfectants will be followed here very closely, since he has recently stated the problem clearly, and given the simplest and best means of solving it. It is also well known that the researches of Koch, Gaffky, and Loeffler concerning many points have caused an entire revolution in the methods of disinfection.

The rules to be followed in testing the germicidal value of a disinfectant, are, briefly, the following:

Pure cultures of well-known bacteria are used as reagents, not mixtures of unknown composition. For a complete knowledge of the rank of the disinfectant, these pure cultures should represent the several groups of micro-organisms which are active in disease and fermentation, *i.e.*, moulds, yeasts, and bacteria. Bacteria which do not form spores should also be represented, as well as the most resistant bacilli (*e.g.*, the hay bacillus, Chapter IV.). But if it is only desired to learn whether a given substance is capable of destroying all organic life, and consequently all living contagia, it is sufficient to use bacillus spores alone, since these are the most resistant living beings known at the present time.

The forms chosen as reagents ought to be easily recognizable by macroscopic characters; consequently chromogenic species are preferable, such as the black *Aspergillus niger*, the pink yeast [" *Saccharomyces glutinis* "], the blood-red *Micrococcus prodigiosus*, etc., etc. The persistence or absence of ability to develop after exposure to the action of the disinfectant is taken as evidence of their life or death.

According to the nature of the disinfectant, and the circumstances under which it is tested, the cultures employed as reagents are used in various ways. Sometimes they are not

It must be remembered that these reagents, excepting, perhaps, the bacillus spores, cannot be kept in a useful state for an unlimited time, but that they generally die after a longer or shorter time. It is, therefore, necessary to ascertain their ability to develop before using them in case they are rather old. It is safest to use freshly prepared material.

The general method of carrying out an investigation is as follows: 1, exposing the bacteria to the action of the disinfectant; 2, removing the latter; 3, sowing or inoculating the exposed bacteria on a suitable culture medium or animal; 4, sowing on inoculating control material at the same time; 5, observing the result of the cultures or inoculations, not merely as to whether or not they grow, but also rapidity of growth, virulence, etc., etc.

When it has been shown by such experiments that a given disinfectant really destroys one of the pathogenic bacteria quickly and surely, it by no means follows that the substance is practically useful for the destruction of this contagium. Before a disinfectant can be recommended, it is particularly necessary to show that it not only kills the germs on our silk threads, bits of papers, and potatoes, but is also capable of attacking them as they occur in nature—in clothing, excrement, sputum, etc. The effectiveness of the most powerful disinfecting agents may under such circumstances be neutralized by chemical changes or the impermeability of the substance which harbors the contagium, which, for example, prevents the successful employment of the corrosive sublimate solution for disinfecting vaults and tuberculous sputum. On the other hand, contagia may occur in nature under circumstances more favorable for their destruction by a given disinfectant than is the case when pure cultures of them are exposed to its action. [Laplace's solution of sublimate in crude hydrochloric acid, diluted for use to the standard ratio of 1: 1,000, has the advantage over the simpler aqueous solution, of not so readily forming insoluble precipitates with albuminoids. —W. T.] How to proceed so as to accomplish the purpose of the investigation, is implied in what has been written above. Either the infected excrement, sputum, or clothing is exposed to the action of the disinfectant and then used for inoculation experiments (*e.g.*, by inoculating guinea-pigs with the tuberculous sputum that has been treated with carbolic acid or

corrosive sublimate, or causing healthy people to wear pieces of clothing disinfected by heat or chemicals); or the micro-organisms mentioned above are used as reagents, carefully mingled with excrement or sputum, or placed in the pockets or under the lining of clothing in which they are disinfected, and their power of development subsequently tested in the usual way.

Finally, a large number of questions must be answered which are of a clinical or technical nature, etc., and hence lie without the scope of this work (*e.g.*, those concerning the dangerousness of the substance, its possible injuriousness to the objects to be disinfected, offensive odor, expensiveness, etc.); and an opinion as to its practical utility can only be reached after these are considered.

The rules given here must be kept in mind in all disinfection experiments, whether referring to the germicidal power of heat, sunlight (Duclaux), sound waves, electricity, fluids, or gases. But the methods must obviously be modified in their details to suit each case. As examples, a detailed account is given here of the best manner of investigating the disinfecting value of a fluid, and of testing a disinfecting oven.

1. Testing a Fluid Disinfectant.

A. *By the Use of Fluid Cultures.*—Equal quantities of rather dilute and more concentrated solutions of the disinfectant are poured into a number of sterilized vessels. With the same Pasteur pipette, an equal number of drops of a well-shaken pure culture is added to each of these tubes, and carefully mingled with its contents by shaking. The time is noted, and the same number of drops of the culture are then added to a control test-tube containing sterile bouillon or 0.7 per cent solution of table salt.

A large number of test-tubes, with 5 to 10 cc. of nutrient jelly in each are kept at 25° to 30° C., so that their contents remain fluid. From each of the antiseptic solutions that have received bacteria, as well as from the control tube, a drop is transferred to one of the tubes of jelly, the same platinum loop being used for all, to insure the transfer of about the same quantity in each case. This is repeated at longer or shorter intervals for the various degrees of concentration, and

the time for which the disinfectant was allowed to act in each case, as well as its concentration, is marked upon the tube.

The appearance or absence of bacteria in these isolation-cultures, as well as their abundance if present, give the data for a determination of the time required by the disinfectant in a certain degree of concentration, to destroy a certain kind of bacteria. It is a weak point in this mode of investigation, that a small quantity of antiseptic is always transferred to the nutrient jelly, together with the bacteria; but this can be assumed to be inactive in the degree of dilution caused by mixing it with the jelly, and this source of error can always be subjected to the test of control experiments.

B. *By Using Cultures Dried on Silk, etc.*—The investigations are carried on along the same lines as the last. Sterile vessels are filled with solutions of an antiseptic of various degrees of concentration. Several pieces of silk, charged with bacteria, are dropped in each. By means of a platinum wire, pieces are fished out at definite intervals, and, after removal of the disinfectant, sown in a gelatinized medium. The removal of the disinfectant is effected by carefully pressing the threads out in sterile filter-paper, washing them in water, and again pressing them between folds of filter-paper. The paper for this use is cut in quadrangular pieces of about 5 sq. cm., folded like sheets of writing paper. These are wrapped in paper in small parcels, and sterilized at 150° C. before use. The control silk is placed in sterile bouillon or 0.7 per cent salt solution, and then washed in the same manner as the pieces that have been exposed to the antiseptic solutions. When the disinfectant has been thoroughly removed by washing and the capillary action of the filter-paper, the pieces of silk are sown in melted jelly or on solid jelly. In the first case, test-tubes are used, which are rolled or laid horizontally while cooling, to facilitate the counting of the germs. In the second case, watch-glasses or small uncovered trays (Fig. 13) are used. Six to ten of these are placed in a larger pair of trays (Fig. 12), sterilized in these at 150° C., and only filled immediately before use. This arrangement facilitates the microscopic control of the cultures, but it makes later contamination possible, and requires a more careful washing than the isolation cultures in test-tubes.

If the threads are not sufficiently washed out, the disinfect-

ant remaining in them may diffuse through the surrounding gelatin in sufficient quantity to prevent all growth about the threads, even when these contain living bacteria—a fact which can cause (and has caused) mistakes. The thoroughness of the washing may be tested in the following manner: Some of the agar-gelatin to be used is inoculated with the same sort of bacteria as those on the threads, just before being poured in the watch-glasses or trays, where it is then allowed to solidify, and the silk is laid on its surface as usual. Some days later, the colonies appear in it, reaching quite to the thread in case the washing has been sufficient, while a sterile zone surrounds the thread if it has not been thorough enough. Attention should be given to this fact in testing the freedom of antiseptic dressings from bacteria by sowing them in nutrient gelatin; control cultures being made by means of a series of thrust-cultures of various bacteria in the immediate vicinity of the pieces of material in question.

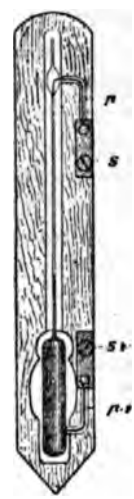

Fig. 69.—Electric Thermometer.

2. Testing a Disinfecting Oven.

For this purpose are needed:

a. A variety of the objects the oven is made for (usually bed-clothes and wearing-apparel) are needed.

b. Thermometers. Usually it is sufficient to have a few maximum thermometers, which, to avoid injury during the investigations, are encased in metal or wood, in the latter case openings being provided to prevent them from checking the penetration of the heat. But if it is wished to learn easily and quickly when a certain temperature (*e.g.*, 100° C.) is reached at a given point within the oven, an electric contact-thermometer Fig. 69) is employed. This consists of a thermometer in the walls of which two platinum threads are fused, one (p_1) entering the mercury in the bulb, the other (p) touching the mercury only when the boiling-point of water (or other desired temperature) is reached. By means of screws (s and s_1), the thermometer is connected with wires that may be passed through the door of the oven and inserted in an electric circuit including a bell which sounds when the circuit is closed.

c. *Bacteria.*—The principal of these are resistant spores, like those of *Bacillus anthracis, B. subtilis, Tyrothrix scaber* (Duclaux), and certain earth-bacilli. The material is prepared as indicated on pages 562–564. For packages, filter-paper is used, folded like the papers used by druggists for "powders," and sterilized at 150° C. The papers are marked and numbered with a lead-pencil, and those containing the different sorts of spores are collected in small parcels which can eventually be tied to a thermometer.

When the material for the test is ready, the oven is packed as it is intended to be in regular use. The thermometers and test-bacteria are distributed thr gh the oven during this process,) nerely between and upon the clothing, but within it, i ; where contagia might easily exist, but where the ar i trates only with difficu y. For instance, mattresses nd i ws are ripped open gh to allow of the insertion ometer and bacteria to the straw, hair, moss or eathu d again closed by sew ng or the use of safety pins; one or re blankets are rolled tightly about thermometer and bac ia, etc. If the bacteria are destroyed under these circumstances, it is evident *a fortiori* that as good results are attainable with the looser packing which may be employed in the daily use of the oven. Care must be taken that the thermometers are not all collected about a single place, but are distributed through the oven.

After the oven is packed, it is best to make a diagram (Fig. 70) of its contents, that the temperature reached and its influence on the bacteria may be subsequently noted at various points, giving an excellent synopsis of the results of the test.

At the end of the experiment, as accurate notes as possible are made of the time for which it was continued, the amount of fuel consumed, etc.; the articles are unpacked, and their appearance, degree of dryness and brittleness, etc., observed, and the thermometer readings made.

The packets of bacteria are wrapped in paper, in which they can be carried to the laboratory without danger of contamination. Cultures are made from them, as outlined on p. 566, either in test-tubes or trays. But it is to be observed that the latter sort of cultures is not suited to garden-earth, because, even when the dirt is poured from the papers very slowly, particles easily fall into adjacent trays. It must,

therefore, be poured on the surface of gelatin which has been allowed to harden obliquely in test-tubes. In larger series of comparative tests, it is well to place the cultures in a brood-oven at 20° C., but isolated experiments are as well made at the varying temperature of the room. Most cultures require to be kept only a week, but those from garden-earth must be watched for a couple of weeks, as they occasionally contain resistant forms which develop very late. It is necessary to note not only whether or not growth occurs, but also whether there is any retardation of the development of the bacteria, and, in isolation cultures, their number.

The final results of the experiment are most conveniently

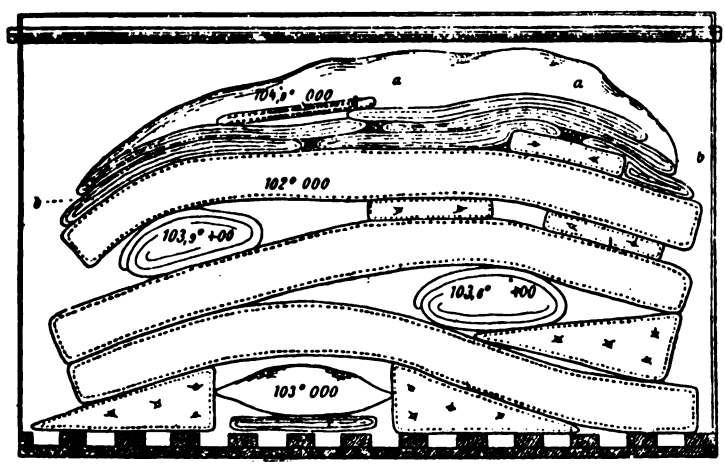

FIG. 70.—Diagram of a Packed Disinfection Oven, with Indication of the Results of a Test.

registered by noting the thermometric and bacteriological observations upon the diagram representing the contents of the oven. In Figure 70, + indicates growth; 0 no development; and the species of bacteria are indicated by the relative position of the marks, which are always arranged in the same sequence—earth, hay, anthrax-bacilli. *E.g.*, within the upper mattress of the Figure, the temperature reached was 102° C., and all three species of bacteria were killed, while the earth-bacilli survived the disinfection within the rolled woollen blankets, where the temperature was between 103° and 104° C., etc.

As has been intimated above, one should be careful not to

confound the power of a disinfectant to check or prevent the growth of the bacteria, with its power of killing them. That a substance, added in a certain quantity to a readily putrefying fluid, prevents decomposition, by no means requires that it should have killed the bacteria in the fluid. The development and dissemination of the germs may, perhaps, have been prevented; and it may be that when brought into a new and favorable soil they would prove very well able to develop. It is not superfluous to mention this perfectly obvious fact, because it is often overlooked, giving origin again and again to errors.

If it is wished to learn the degree of concentration in which a given material begins to check the growth of different micro-organisms, and that in which it renders growth entirely impossible, the following method is employed, bacteria and moulds being used, selected as indicated on p. 561.

A suitable number of test-tubes are filled with nutrient material (generally gelatin) adapted to the organisms selected. Some of these glasses are left untouched, serving for control, while larger or smaller quantities of the substance to be tested are added to the rest, so that all degrees of concentration are obtained. In preliminary experiments, it is best to pour nearly equal quantities of gelatin into all of the tubes, adding to them different quantities of a strong solution of the substance, of known concentration, by means of glass pipettes graduated to 0.05 cc. From these data, the percentage of the substance in each culture glass can readily be calculated.

The species of bacteria on which it is desired to test the disinfectant is sown in the vessels prepared in this way, the material used for inoculating all being taken from a single culture and by means of the same needle or pipette. The quantity used for inoculation, and the manner in which the needle is used should also be, as far as possible, exactly the same for the different glasses, which are then observed daily, the least degree of concentration which permits no growth along the thrust and the least which perceptibly checks the growth of the bacteria, being noted. The latter point is chiefly indicated by a retardation of development, and by a change in the macroscopic habit of the colonies.

Figure 71 illustrates this. It represents three test-tubes with peptonized meat-infusion gelatin to which 0.05 per cent of carbolic acid was added in the first, 0.4 per cent in the second,

and 0.7 per cent in the third. The same bacillus was sown in all three glasses, which eight days later presented the appearance represented. In the first tube, the appearance of the culture was the same as in the untreated control-tube—a large close irregular felt of bacilli floating on a quantity of melted gelatin at the very top, and below, above the thrust in the still solid gelatin, a number of dot-like colonies, from some of which, especially the uppermost, fine undulating threads radiate in all directions. In the second tube, during the same time, the felt of bacilli next the surface had not reached the glass, liquefaction was limited to a small hemispherical depression immediately about the needle-thrust, while no trace was to be seen of filaments from the deeper colonies, which did not approach the bottom so nearly as in the first glass. The third tube showed little surface growth, no liquefaction, and only a short, firm, inversely conical colony in the solid gelatin. Very similar differences are found in cultures of Koch's bacillus of mouse septicæmia, grown in gelatin with and without carbolic acid. The peculiar cloud-like fine growth never appears in the cultures containing much carbolic acid, in which the bacilli show as small, dense, dot-like colonies.

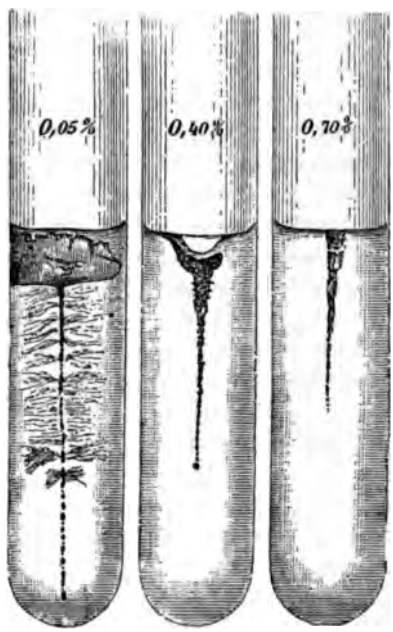

FIG. 71.—Three Cultures of *B. anthracis* after Seven Days' Growth in Peptonized Meat Gelatine, to which has been Added the Percentage of Carbolic Acid Indicated in Each.

This prepares the observer for morphological changes in the microscopic appearance of the bacteria so grown; and it must also be remembered that under such conditions a permanent physiological transformation of the bacteria has been induced, as in the attenuation of the virulence of *B. anthracis* by cultivating it in carbolic acid (Toussaint, Chamberland, and Roux)—a result which gives especial interest to experiments of this sort.

CHAPTER XIII.

ROSCOPIC EXAMINATION, AND STAINING OF BACTERIA.

E side of the microscor... ination of bacteria has
ly been considered in C X. (moist chambers), and
tching the plate-cu och, where not only the
arities of the colonies r entire, lobed, fringed,
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es being even a nost powerful immersion
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it is wished to l cells more closely, the
ay need only be sterile platinum needle,

and the adhering material distributed through a small drop of 0.7-per-cent solution of table salt (free from bacteria), spread in a thin layer under a cover-glass. If the bacteria grow in a fluid medium, a small drop of the culture is placed under the cover-glass without further treatment except for final dilution with the standard salt solution. The addition of such a neutral fluid may occasionally facilitate the investigation, not only by isolating the germs, but by modifying the differences of refraction.

If such preparations are to be examined for a longer time or with an immersion lens, it should be sealed with paraffin, which is best applied by means of a glass tube 4 mm. in diameter filled with paraffin and drawn out to a short open point, from which the melted paraffin flows.

The movements of living bacteria cannot be observed long in such sealed preparations, since they are stopped by want of oxygen. This may be put off for a time by having a number of rather large air-bubbles under the cover-glass, or, in case the bacteria are contained in water, by introducing one of the filamentous green algæ (Engelmann). Impelled by their need

of oxygen, the bacteria collect about the bubbles or algæ (the latter of which continue to set free oxygen, as a result of assimilation), and keep up their motions until the supply is exhausted or the activity of the algæ ceases. The study of the manner in which the bacteria move can be facilitated by slightly coloring them, as indicated below. The movements of the very active species can be checked by compressing them strongly by pressure on the cover-glass. All motion in a limited part of the preparation may be stopped by the same means, individuals here and there afterward recommencing their movement, but at first very slowly.

The best way of studying the movements of bacteria is, naturally, by the use of a moist chamber, Ranvier's moist chamber, and the method indicated on p. 537 is especially advisable, as the difficulties of using the hanging drop are thus avoided.

The use of staining fluids, especially certain aniline colors, is an indispensible adjunct in the microscopic study of bacteria. The employment of the methods of staining now used, not only greatly facilitates the demonstration and observation of bacteria in fluids, but the detection of structural peculiarities which escape observation in the unstained cells, *e.g.*, the flagella of certain bacteria, the peculiar ends of the cells of *B. anthracis*, etc.; and it also discloses chemical differences which are sometimes of extraordinary importance for clinical diagnosis, *e.g.*, in demonstrating the tubercle bacillus, staining has also rendered it possible to obtain handsome permanent preparations of free bacteria, and, above all, to demonstrate bacteria within the tissues and to study their distribution in the organs and their relations to the cells. The development of the technology of staining to the high point it has now reached is due chiefly to three men, Weigert, Koch, and Ehrlich.

The dyes used in bacteriological investigation nearly all belong to the large class of aniline colors, and especially to the group called basic by Ehrlich, who first called attention to the fact that the aniline colors are divisible into two main groups: the acid colors, in which the staining principle is an acid (*e.g.*, ammonium picrate); and the basic, consisting of a staining base in combination with an acid that does not stain (*e.g.*, acetate of rosaniline). Methylene blue, fuchsin,

gentian-violet, vesuvin, etc., belong to this group of basic dyes (used by histologists as nuclear stains), which have proved especially adapted to the staining of bacteria, free or *in situ*, so that it has proved possible by their use to stain all known pathogenic bacteria in sections, strongly, permanently, sparingly, and distinct from the invaded tissue. Ehrlich likewise calls those dyes neutral which are formed by the union of a base and acid both of which are capable of staining (*e.g.*, picrate of rosaniline).

Naturally, it is not always possible to at once secure all of these desirable results equally well, and especially soft staining of the histological elements is often advantageously made to give place to the intense coloring of all bacteria present. But Baumgarten has, for instance, succeeded by a rather complicated method in showing upon the same slide the tubercle-bacilli and the caryokineses resulting from their invasion. Baumgarten's method is the following: The diseased rabbit is killed, and small pieces of the tuberculous organs are cut out as quickly as possible and at once cast into 0.2-per-cent chromic acid, where they are hardened for forty-eight hours, then washed out thoroughly in running water for as much as twenty-four hours, and rehardened for twenty-four hours in strictly absolute alcohol. The thinnest possible sections are laid in freshly prepared aniline-methyl violet (No. 8) for a long time (as much as forty-eight hours), washed not to exceed thirty seconds in 1 part of nitric acid to 5 of water, the decolorization being then completed in 60-per-cent alcohol (No. 17), after which they go into a mixture of equal parts of a concentrated alcoholic solution of fuchsin (No. 1) and distilled water for half an hour to an hour, then for five to ten seconds in an aqueous solution of methylene blue (1 : 1,000), and finally for five to ten minutes in absolute alcohol, changed once or twice. The sections are finally mounted in balsam thinned with bergamot oil, but without chloroform.

Instead of the more complicated method of staining the nuclei with fuchsin and methylene blue, according to Baumgarten a concentrated solution of vesuvin in 1-per-cent acetic acid may be used.

For securing intense and permanent staining, the same means are employed as in dyeing on a larger scale; *i.e.*, by the prolonged action of the staining fluid; warming the lat-

ter, either for a long time in the thermostat at 40° to 50° C., or more intensely but for a shorter time over the flame; or by the use of mordants, *e.g.*,—potash, carbolic acid, aniline oil, or tannin—which have a certain tendency to unite with both the dye and the object to be stained, so that they serve as a sort of connecting link.

The possibility of staining bacteria in contrast with the surrounding tissue is partly due to the different "elective" power of various dyes (Ehrlich), *i.e.*, their different power of staining certain tissue elements; and partly to the different strength with which they stain various parts of the preparation, *i.e.*, the different stability of the union they form with them. The following experiment of Ehrlich and Schwarze illustrates in a striking way the different elective power of three acid aniline colors, aurantia, indulin, and eosin. When a cover-glass preparation of blood is made by distributing it in a thin layer, drying it, and heating to 120° C., and the pigments are tested on it, it is seen that each of the latter possesses the power of coloring the red corpuscles as well as the nuclei of the white corpuscles and the peculiar granules, found in some of the white cells, which Ehrlich calls α-granules. But if the blood-preparation is treated with a solution of the three dyes in glycerin (made by adding an excess of eosin and indulin to a mixture of 1 part of saturated solution of aurantia in glycerin, and 2 parts of pure glycerin), the hæmoglobin is colored yellow by the aurantia; the nuclei, gray or black by the indulin, and the α-granules, red by the eosin. The fact that certain parts of the preparation hold the coloring matter more tenaciously than others, is used in demonstrating bacteria in sections, the general plan being to overstain the entire preparation, subsequently securing the differentiation by decolorizing (and finally staining in some contrasting color) certain parts, leaving the others colored as at first. The degree of decolorization can be regulated by the substance chosen to effect it. If, for example, we have a section of an organ containing bacteria, which has lain in a strong solution of methyl violet, and wash it in water, microscopic examination will show the bacteria, as well as the protoplasm and nuclei of the cells, colored deep violet (diffuse staining). If it is washed in dilute acetic acid (p. 580, No. 11), the protoplasm becomes decolorized, while the bacteria and nuclei retain the color

(nuclear staining). If it is washed in potassium carbonate (No. 15), the coloring matter is also driven from the nuclei, the bacteria alone remaining stained (isolated staining of the bacteria). By still more powerful agents, such as 25-per-cent nitric acid or hydrochloric acid, most species of bacteria can likewise be decolorized, so that only a very few sorts remain stained (tubercle stain); but repeated treatment with strong solutions of mineral acids, if continued sufficiently long, also removes the stain from these species, and it must be remembered throughout that the time for which the preparations are exposed to the action of the decolorizing agent is of decisive importance for the result, since the power of the different elements to resist decolorization usually differs only in degree, not in kind. In each case, therefore, it is necessary to avoid decolorizing too little or too much, and as it is not easy to give very exact instructions as to the time needed, this is one of the points on which long experience plays an important part.

To further differentiate the bacteria from the tissue elements, and to bring the form and disposition of the latter out more clearly, multiple staining (usually double staining) can be employed, either by using a new staining fluid on the partly decolorized preparations (successive staining, *e.g.*, No. 17), or by treating them with a fluid which at once decolorizes and restains them in part (replacement staining). Treating the same preparation wit two colors is also sometimes resorted to for another purpose, namely to render the staining more resistant toward decolorizing substances, either by forming a new compound color, or otherwise, *e.g.*, the gentian-violet-iodine method (Gram) and the fuchsin-methylene-blue method described on p. 586.

Occasionally double staining may be secured by the employment of a single dye, *e.g.*, when methylene blue is used to stain a section which includes bacteria as well as the peculiarly granulated connective-tissue cells known as "Mastzellen," the bacteria are colored blue, and the granules violet. These granules (the γ-granules of Ehrlich) also deserve notice for another reason. Since, like bacteria and nuclei, they are stained by basic aniline colors, and have about the size of micrococci, they may be mistaken for the latter, as has often been the case with inexperienced observers. As an especially

favorable object for the comparative study of micrococcus cells and these γ-granules, I can recommend the mesentery of a rather lean mouse, dead of suppurative peritonitis as a result of inoculation with pyogenic staphylococci. The mesentery is spread out on a cover-glass which is slipped beneath it while it is still attached to the intestine, by the weight of which it is stretched over the glass. As soon as it has dried fast, the part projecting around the edge of the glass is cut away, and it is treated as if it were an ordinary cover-glass preparation (by drying, passing through the flame, etc.), and stained by methylene blue. Among the blue cocci will be found small clusters of granules of unequal size, grouped irregularly around an unstained nucleus—for the nuclei of these cells, unlike those of other connective-tissue cells, are not colored by this mode of staining with basic aniline colors. In double-staining, colors are naturally chosen which contrast sharply and prettily with one another—*e.g.*, fuchsin and methyl green; fuchsin and methyl blue; methyl violet and vesuvin [or methyl violet and eosin].

An extremely large number of dyes have gradually come into use in various ways for staining bacteria; but only a limited number of stains and methods will be considered here, and it is best, for beginners especially, to be content with one or two of the most universal and important methods, practising them carefully until they are mastered, before going further. It is not possible to limit one's self exclusively to a single dye, for the reason that the behavior of different bacteria toward the various staining fluids, and when different methods are used, is of diagnostic importance, while there is no one dye which stains all bacteria equally well. *E.g.*, the slight power of methylene blue to stain the bacillus of leprosy can be used to distinguish the latter from that of tubercle, which otherwise resembles it closely (*cf.* p. 594). In other cases, the behavior when the Gram method is employed can be utilized for diagnosis; *e. g.*, with gonococci, which (like the typhoid bacillus, the cholera spirillum, and the microbes of chicken cholera and the septicæmia of mice) are decolorized when the Gram method is used, while other pyogenic micrococci, which closely resemble them, retain the stain. The most nearly universal pigment is methylene blue, a substance introduced by Ehrlich, which can well be used as the principal stain. By employing

it in the manner indicated below (No. XIII.), Kühne succeeded in staining *in situ* all of the bacteria that he investigated. In leprosy and mouse septicæmia, alone, he failed to obtain completely satisfactory results, and for the bacilli of these diseases he employed fuchsin. Consequently, it is best to carefully practise this "universal method with methylene blue;" and if to this are joined one of the tubercle methods (*e.g.*, No. XVIII.), and the Gram method, one is well equipped, so far as sections are concerned. It is also best to confine one's self to a few methods for cover-glass preparations.

The materials employed, in the methods described below, are the following: Distilled water, absolute alcohol, glycerin, acetic acid, hydrochloric acid, nitric acid, sulphuric acid, chromic acid, carbolic acid, aniline oil, potash, potassium carbonate, potassium acetate, potassium iodide, lithium carbonate, iodine, clove oil, bergamot oil, cedar oil, turpentine, xylol, Canada balsam, shellac, paraffin, fuchsin, methylene blue, methyl violet, gentian violet, methyl green, vesuvin, picro-carmine, and extract of logwood. Different aniline colors bearing the same name may differ to such an extent as not to be equally adapted to histological purposes, so that attention should be given to the source and trade mark of good sorts.

All of the aniline colors named should be kept in stock in the dry form. Fuchsin, methylene blue, methyl violet, and gentian violet may be further kept in a saturated alcohol solution (No. 1), *i.e.*, 25 gm. of the dye to 100 gm. of absolute alcohol, which always leaves an abundant excess of undissolved pigment in the bottom of the flask. Vesuvin (or Bismarck brown) is best kept only in powder, but if a solution is to be kept, this is best made (No. 2) by saturating equal parts of water and glycerin.

For use, aqueous solutions of the powders (No. 3) may be directly prepared, but these do not keep long, and are therefore always freshly prepared from water free from bacteria, and are filtered before use. It is very convenient to keep a little of the dry pigment constantly used, in this way, on a little filter in a glass funnel. When it is needed a small quantity of water is poured over it, and the filtrate is collected, the powder soon drying again. Dust is kept from it by covering the funnel with a layer of filter-paper.

When it is not exceptionally necessary to avoid every trace

of alcohol in the staining fluid (as is, for example, the case when staining living bacteria), the aqueous solution is replaced without disadvantage by that (No. 4) made by adding a suitable quantity of the saturated alcoholic solution (No. 1) to water. This diluted alcoholic solution is more durable than the aqueous, but it usually requires renewal once or twice a month, so that it is best to prepare it when needed, by adding five to six drops of No. 1 to a watch-glass full of distilled water.

The principal mordants used are 0.01-per-cent solution of potash (Koch, Loeffler); 5-per-cent carbolic acid (Ziehl); and aniline-water (No. 5), a concentrated aqueous solution of aniline oil, prepared by very thoroughly shaking about 1 part of aniline oil and 20 parts of distilled water in a test-tube, allowing it to stand five minutes, and filtering through a filter moistened with distilled water. (It must be perfectly free from turbidity, or it should be again shaken, and refiltered.) The staining fluids with mordants for which we shall find application, are:

(No. 6.) Kuehne's carbolic blue. 1.5 parts of methylene blue, and 10 parts of absolute alcohol are triturated lightly in a watch-glass with 100 parts of 5-per-cent carbolic acid which is added little by little. When all is dissolved, it is bottled. To facilitate rapid preparation, several test-tubes with feet may be graduated to 20, 22, and 24.2 cc. (*cf.* Fig. 72).

(No. 7.) Ziehl's carbolic fuchsin. 1 part of fuchsin, 10 of alcohol, and 100 of 5-per-cent carbolic acid.

(No. 8.) Aniline methyl violet (Ehrlich-Weigert). 11 cc. of the saturated alcoholic solution of methyl violet, 10 cc. of absolute alcohol, and 100 cc. of aniline-water. Or the dry powder may be added in excess to aniline water. [In Koch's laboratory it is customary to add the stock alcoholic solution (No. 1) to a watch-glass of aniline-water until the latter is shown to be saturated by the formation of a film at top.]

(No. 9.) Aniline gentian violet (Ehrlich). 5 cc. of the saturated alcoholic solution of gentian violet, to 100 cc. of aniline-water.

(No. 10.) Loeffler's alkaline blue. 30 cc. of the saturated alcoholic solution of methylene blue to 100 cc. of 0.01-per-cent caustic-potash solution.

A large part of the chemicals enumerated above are used for washing preparations for decolorization or differentiation.

For this purpose, water, alcohol, and glycerin (all perfectly free from acid) are used, as well as clove-oil and aniline-oil, and acids and salts in the following forms:

(No. 11.) Very dilute acetic acid (0.5 per cent to 1 per cent).

(No. 12.) Very dilute hydrochloric acid (10 drops of the acid to 500 gm. water).

(No. 13.) 75 parts of water containing 25 parts of nitric acid (Ehrlich), or the same quantity of hydrochloric or sulphuric acid.

(No. 14.) Lithium water (Kuehne). 6 to 8 drops of a concentrated aqueous solution of lithium carbonate and 10 gm. water. For neutralizing an acid washing fluid.

(No. 15.) Potassium carbonate solution (Koch). Equal parts of a saturated aqueous solution, and water (Koch); or 2 parts of a 2-per-cent aqueous solution, and 1 part of absolute alcohol (Malassez and Vignal).

(No. 16.) Gram solution. Iodine 1 part; potassic iodide, 2 parts; distilled water, 300 parts.

(No. 17.) Alcohol, 60 parts; water, 40 parts (Koch). For colored wash-alcohol (Kuehne), see p. 590.

(No. 18.) Aniline-oil blue. Kuehne recommends rubbing as much methylene blue as can be raised on the point of a knife, with 10 gm. clarified aniline oil, and allowing the excess of undissolved pigment to settle in a bottle. A few drops are added to aniline oil in a watch-glass, until the desired concentration is reached.

The manner of using these staining and decolorizing agents, as well as the others for hardening, anhydrating, clearing, mounting, and sealing preparations, receives more detailed consideration under the several methods described below.

In what follows, it is assumed that the common microscopic appliances and methods are understood. Staining is usually effected in small glass trays (Fig. 13), "individual salt cellars" or watch-glasses. Some of the trays must have ground tops so that they can be tightly sealed with a glass plate if they are to kept at an elevated temperature for some time. Watch-glasses, which are inconvenient because of their lack of stability, are necessary if sections are to be stained by heating over the flame. In this case, they are conveniently placed upon the stand shown in Figure 72, which consists simply of a strip of sheet tin with three holes having a somewhat

smaller diameter than the watch-glasses. The stand is also useful for filtering, as indicated in the cut.

Staining Bacteria in Fluids.

A. *By the Simple Addition of the Staining Fluid.*—A little drop of very dilute aqueous solution (No. 3) of fuchsin or methyl green (Macé) is placed on a slide, a small quantity of the culture, etc., is distributed through it with a platinum needle, and a cover-glass applied. The staining fluid must usually be so dilute that it appears nearly colorless under the microscope. When pure and extremely dilute aqueous solu-

Fig. 72.—Tin Support for Funnels and Watch-glasses, in Staining and Filtering.

tions of fuchsin are used, the bacteria can remain alive and continue their motions after staining (Salomonsen).

If a drop of the culture and one of a more concentrated staining fluid than in the last case are placed in proximity on the slide and covered with a single cover-glass, a series of bacteria may be found in the same preparation, showing all gradations from cells that are unstained to others strongly overstained.

A rapid microscopic view of a large number of crowded colonies in a plate-culture is obtained by the following method: A well-cleansed cover-glass is laid upon the gelatin over the colonies and pressed firmly into contact with it everywhere, by a glass rod or pair of forceps. Fragments of the superficial colonies adhere to the cover, forming an "impression-preparation" of the culture, so that when it is removed from the gelatin and lowered on to a drop of staining fluid on a

slide, the opportunity is given to see small samples of the contents of all of the colonies isolated. Any of these preparations can be sealed with paraffin, as described above.

B. Staining Preparations Dried on the Cover-glass.—Weigert was the first, in 1871, to recommend an aniline dye (methyl violet) for staining bacteria. Shortly afterward, without knowing of Weigert's work, I introduced fuchsin as particularly good for staining bacteria, and referred especially to its value as a means of diagnosis in the microscopic analysis of putrefying blood. By the introduction of the basic aniline colors, the demonstration and examination of bacteria in fluids was greatly facilitated, but a further and decisive advance in methods was made in 1875, when Koch showed how bacteria might be colored after drying them in a very thin layer upon the cover-glass, which, likewise, rendered possible the complete micro-chemical treatment of the bacteria which now plays so important a part. The great advantages of this method have caused it to be almost exclusively used in all chemical examinations of blood, pus, urine, and sputum; consequently the making and examining stained cover-glass preparations will be described in detail in the following pages. Obviously, the use of such preparations does not render superfluous the simple

When such a dried preparation of blood, pus, sputum, or other fluid which contains albumen, is at once stained, two defects are sometimes observed; sometimes the dried film separates in part from the glass; sometimes the presence of soluble albuminoids causes disturbing precipitates in the preparation. These are avoided when the albuminoids are rendered insoluble by suitable hardening. The second defect can also be avoided by using aniline brown (Bismarck brown or vesuvin) in glycerin (No. 2), and washing in pure glycerin (Koch). Absolute alcohol (Koch) may be used for this purpose, the cover-glass being placed in it for some time, but the requisite time varies much for different preparations. Partly for this reason, and partly because of its slowness, this method is far inferior to that of Ehrlich, by heating up to 120° to 130° C. for two to ten minutes. (In a protracted exposure to this temperature, *e.g.*, for an hour, as in Ehrlich's studies of the granules of the white blood-cells, the bacteria have been found to lose their power of staining.) This heating may be effected in the sterilizing oven (Fig. 1), but it is more convenient to follow Koch in passing the cover three times through the flame of a Bunsen burner. The cover-glass is seized with the forceps by one corner, the smeared side up, and passed three times through a vertical circle about a foot in diameter, the clean side of the cover being brought down against the top of the flame each time. The best rapidity for the flaming, upon which success depends, is reached by taking about three seconds for describing the three circles.

Of the various ways in which the staining fluid and the hardened preparation can be brought together, we usually employ that of allowing the cover-glass to float upon the fluid, film downward. In all of the following manipulations, care must be taken to remember which side of the cover bears the bacteria, for when the film is very thin it may be difficult to distinguish it. Sometimes it may be recognized by scratching upon the cover with a sharp pin, the irregularities of the smeared side being felt, or the scratches seen.

The smeared and dried cover-glasses can be kept, with or without hardening, for an indefinite time before staining, being simply laid in an ordinary cover-glass box, the different sets separated by labels of the size of the covers. [For clinical purposes, it is convenient to use a small oblong box, a couple

of inches long, with a rack inside like a slide-box. Twenty or more clean covers are easily carried in such a box, which is small enough to be slipped into the vest pocket or instrument-case, so that they are always ready for use at the desk or bedside.—W. T.] Two opposite corners are lifted with the thumb and forefinger of the right hand, the cover is held horizontal, and allowed to fall upon the fluid from a height of several centimetres. The time required for the action of the staining fluid varies according to circumstances from a few minutes to an entire day. Long staining at the temperature of the air can often be replaced by a shorter staining at a higher temperature (Koch, Loeffler), *e.g.*, No. IV., p. 586, *infra*. This is best effected by setting the watch-glass of staining fluid on which the cover floats, upon the tin stand (Fig. 72), and heating it with a small flame until vapor rises freely from the surface. The lamp is then removed for a short time, after which the heating is renewed, and this is repeated several times for a few minutes, or longer, as may be necessary. Sometimes it may be convenient to heat the fluid until it begins to boil, *e.g.*, in No. IV.

When the staining, or, rather, overstaining of the preparation is finished, the latter is washed (partly decolorized or "differentiated"). This is effected according to circumstances by the use of one or other of the fluids enumerated above (*cf.* pp. 579 and 580), which is then removed with water either by rinsing under the faucet or with a wash-bottle, or by moving the cover back and forth in a large dish of distilled water. Washing out the excess of color is the most difficult part of staining, because no rules can be given as to the length of time it ought to be continued in each case: frequently the right time is only learned by experiment. When it has been finished, the preparation can be examined at once in distilled water or glycerin.

It should also be observed that preparations stained with Bismarck brown or vesuvin (No. 2), can be permanently mounted in glycerin, while this substance decolorizes preparations stained with the other aniline colors. On the other hand, a concentrated solution of acetate of potassium (1 : 2) serves especially well, according to Koch, for the preservation of bacteria stained with violet or fuchsin, and, it may be added, of unstained bacteria; but it should not be used for those stained brown.

If the preparation is to be permanently mounted in balsam, it is next dried, by carefully wiping off the clean side of the cover with a piece of soft linen, and holding it obliquely with one edge upon a piece of filter-paper, so that as much water as possible will flow off or be absorbed by the paper. Any large drops remaining on the film are carefully removed with filter-paper, and the cover is allowed to become air-dry. To hasten the drying, the cover may be pressed between folds of filter-paper (Ehrlich), waved back and forth through the air, or air may be blown over it by means of a rubber bulb furnished with a pointed glass tube (Kuehne).

The dried preparation is mounted in Canada balsam. It is most convenient to use this greatly thinned with xylol, and kept at hand in collapsible tubes. Turpentine can also be used for this purpose, but chloroform [and benzol] are to be avoided, as they remove the basic aniline colors. Of the ethereal oils, clove-oil is especially apt to decolorize the bacteria, so that sections should rather be cleared with turpentine, oil of bergamot, or cedar-oil. A drop of this is applied to the middle of the slide, and the cover inverted upon this, spreading it in a thin layer by its weight. Further treatment is unnecessary, but as it requires a long time for the xylol-balsam to harden sufficiently to fix the cover immovably, it is convenient to seal the preparation by means of a filtered alcoholic solution of shellac, which may be given a handsome green color by the addition of a little methyl green. Several layers of this cement are painted around the edge of the cover.

In the preliminary examination of a fluid containing bacteria, a less complicated method is used. After drying and flaming the cover-glass preparation, it is stained by a diluted alcoholic solution (No. 3) of methylene blue or fuchsin, rinsed with water, and examined at once in water, or, after drying, in cedar-oil (*cf.* No. 1).

Methods of Staining Cover-Glass Preparations.

(I.) *Koch's Original Method* (1878).--The dried film is stained for a few seconds, or a little longer, with a solution of methyl violet or fuchsin (a few drops of the saturated alcoholic solution to 15 to 20 cc. water), washed with water or acetate of potassium (1:10), dried, and mounted in balsam;

or it is stained with vesuvin dissolved in equal parts of glycerin and water, and washed and mounted in glycerin.

(II.) *Kuehne's Methylene-Blue Method.*—The film, after drying and flaming, is stained for five minutes in carbolic blue (No. 6), rinsed in water, differentiated by laying in dilute hydrochloric acid (No. 12) for a few seconds or a little longer according to the thickness of the film, rinsed a moment in lithium-water (No. 14), washed under the water-jet for fifteen seconds, dried—if necessary by use of the bulb—slightly warmed over the flame, cleared in xylol, and mounted in balsam.

(III.) *Gram's Method.*—The flamed film is treated for one to three minutes with aniline gentian violet (No. 9), laid in the iodine solution (No. 16) for an equal time, washed in alcohol till it appears completely decolorized, dried, and mounted in balsam.

(IV.) *Koch-Ehrlich-Weigert Tubercle Method.*—The dried and flamed film is heated in a watch-glass of Weigert's aniline methyl violet (No. 8) until bubbles begin to form beneath the cover-glass, when it is allowed to stand five minutes, decolorized in a tray of 25-per-cent nitric acid, in which it is moved back and forth for at most five seconds, immediately rinsed in 60-per-cent alcohol (No. 17) until the blue color disappears (usually not over one or two seconds), counter-stained for five minutes in a saturated aqueous solution of vesuvin, rinsed in water, dried, and mounted in balsam.

(V.) *Ziehl-Neelsen Tubercle Method.*—The flamed film is floated on a watch-glass of carbolic fuchsin (No. 7) three to eight minutes (with heat), decolorized in 25-per-cent nitric or sulphuric acid, treated with 60-per-cent alcohol until only a rosy tint remains, the acid then being completely washed out in a large quantity of water, dried, and mounted in Canada balsam, with or without previous clearing in xylol.

[For rapidly staining the hardened sputum film, the following commonly-used method leaves little to be desired: The cover-glass is held in the forceps by one corner, film up, a large drop of carbolic fuchsin is placed on it so as to entirely cover the upper side, and it is heated directly over the flame until it steams fully or even boils, care being taken not to let any part become dry. If necessary, a second drop of the staining fluid is added as the first evaporates, and the heating is con-

tinued for, perhaps, half a minute. After rinsing most of the staining fluid off under the faucet, the cover is dropped into *very* dilute nitric acid until the red color changes to a dull olive, or begins to disappear entirely (which usually requires very few seconds), after which it is at once moved about in a dish containing a considerable quantity of alcohol until the dye, which has resumed its original red color, ceases to be given off in clouds. If the film still retains any noticeable color, it is dipped into the acid once more and again washed in alcohol, after which it is counter stained with methylene blue, rinsed in water, and may be at once examined, or dried and mounted in balsam. By this method, a good permanent preparation may be had under the microscope within five minutes of the time when the needle is first dipped into the sputum for the transfer of a little to the cover-glass.

While there are some advantages in floating cover-glass preparations upon the staining fluid, as the author recommends, it is more common to keep dilute alcoholic solutions (No. 4) of methylene blue, gentian violet, and fuchsin, as well as the standard alkaline blue (No. 10) and carbolic fuchsin (No. 7) in 2 oz. wide-mouthed bottles closed with bored corks through which dropping-tubes pass into the middle of the bottle, so that a drop of the desired staining-fluid may easily be allowed to fall upon the hardened film, heat being applied when necessary by holding the cover above a Bunsen burner until steam begins to rise.—W. T.]

Staining Spores on the Cover-glass.—When bacilli which contain spores are stained by the above methods, the spores remain uncolored, so that they appear as colorless spots within the strongly colored rods. This indisposition of the spores to receive coloring matters can be overcome in various ways, and it was simultaneously shown by Buchner and Hueppe that a prolonged exposure to heat, which even unfits the vegetative cells of bacteria for staining (*cf.* p. 583, Ehrlich), exactly adapts the spores to the reception of basic aniline colors in aqueous or dilute alcoholic solutions.

(VI.) If, instead of passing the cover-glass through the flame three times to harden it (p. 583), it is flamed ten times, or heated fifteen to twenty minutes at 120° to 180° C., and then stained with an aqueous solution of one of the usual basic colors, the spores become deeply stained; but the staining of

the spores is isolated, because, as has been said, the rods have lost their receptivity for the dye.

There is, however, a means of obtaining double-stained preparations in which the spores take one color, the rods, another: namely, by an extremely intense application of the Ehrlich tubercle method.

VII. The cover-glass film is hardened in the flame as usual, three times, stained for an hour floating on hot aniline fuchsin (p. 581), rinsed in water, decolorized in 25 parts hydrochloric acid, 75 of alcohol, and counter-stained in a saturated aqueous solution of methylene blue.

There is a great difference in the readiness with which the spores of different moulds may be stained. [*B. Megatherium* and *B. subtilis* are good species to practise with, *B. anthracis* is among the more difficult. The endospores of yeasts may be stained by the same methods, decolorization being more difficult, or staining without the addition of an acid. The reagent is best used upon the cover, as in tubercle staining, but results, but it must be renewed several times, correspondingly prolonged.—W. T.]

[illegible] OF BACTERIA.

[illegible] bacteria, *e.g.*, the forms of *Beg-*[illegible] thoroughly studied by Warming, [illegible] by aid of a good objective without [illegible]. In the case of smaller forms, they [illegible] staining them, or even by means [illegible] but none of the methods so far [illegible] to this purpose. Koch, however, suc-[illegible] them by the use of a saturated aque-[illegible] logwood, added to the fluid contain-[illegible] permanent preparations were made as

[illegible] dried on the cover-glass, stained [illegible] of logwood, laid in dilute chromic [illegible] brown combination with the dye), [illegible].

[illegible] replacement of chromic acid by neu-[illegible] prepared by adding 5-per-cent soda [illegible] to dilute chromic acid. He recommends

the following as the most certain means of staining the flagella:

(IX.) The cover-glass preparation is boiled for five minutes upon black logwood ink ("Kaisertinte"), from which it is placed for fifteen minutes in dilute neutral bichromate of sodium, this being repeated several times.

Staining Bacteria in Sections.

When it is only necessary to demonstrate the presence of bacteria in the various organs, it often suffices to make cover-glass preparations by rubbing on it a little of the juices from a fresh cut surface; but a more exact examination of the number of bacteria, and of their distribution in the tissues, can be made only by means of sections. Before Weigert provided methods of staining bacteria *in situ*, no means of demonstrating them existed, except by the use of acids and alkalies, to which they show great resistance.

(X.) When a fresh section, or one hardened in alcohol, is treated with strong acetic acid or dilute (2 per cent) solution of caustic potash or soda, it becomes almost transparent, only the bacteria resisting the acid or alkali, and so becoming evident, especially when collected in masses in or without the vessels; hence such nests of cocci were seen and described long before their nature was known, *e.g.*, by Beckmann, in the vessels of the kidney. Later, the potash method came to play an important part in the study of pyæmia early in the seventies, *e.g.*, in the work of Hj. Heiberg; and quite recently it has been used in isolated cases. It is thus used to render collections of typhoid bacilli evident in the tissues; and, even before knowing of Koch's investigations Baumgarten had seen tubercle bacilli by the use of the potash method. Still, in general, this has lost its importance since the introduction of staining methods.

One condition of a good staining of sections is their being well and completely hardened. The organs are cut into small pieces and hardened in a large quantity of absolute alcohol.

[If the bottle in which the pieces are to be hardened is filled half full of loose cotton, so that the tissues are kept near the top of the alcohol, the portion of this which becomes more charged with water tends to sink to the bottom because of its

greater specific gravity, and it has been claimed that in such cases more thorough hardening is effected.—W. T.]

As thin sections as possible are cut from the well-hardened tissues by the use of a razor or microtome.

[In Koch's laboratory it is now customary to use a drop of melted glycerin-jelly for attaching the organ to a cork, by means of which it clamped in a Schauze or other sledge-microtome, without any sort of imbedding. If perfectly hardened material is used, fairly good sections are obtained in this way, the sectioning of course being done under alcohol; and there is no danger of the proper staining of the bacteria being interfered with. But in many cases, where the organs to be sectioned are rather large, brittle, etc., and the bacteria will not be injured by the preparatory treatment, the tissue may be imbedded in celloidin for sectioning in the usual way under alcohol; or it may be impregnated with paraffin melting at about 50° C., and imbedded in this for sectioning dry—preferably with some form of rocking-microtome. In the latter case, if the organ is small, ribbon sections may be obtained and stained on the slide, in the way so generally employed now by histologists, and especially embryologists; or the paraffin may be removed by placing the sections in turpentine for a few moments, and afterward in alcohol, after which they are stained individually as if cut without imbedding.—W. T.]

The staining of sections is essentially the same as staining cover-glass preparations; but it must be observed that as a rule they require a longer treatment with the staining-fluid, are less tolerant of heating in the latter, and require more powerful decolorizing media for differentiating the bacteria, while anhydration before they can be mounted in balsam is rarely effected by drying, but by the use of alcohol or anilin oil (Weigert). To prevent these fluids from at the same time partly decolorizing the preparation, Kuehne has recently adopted the plan of anhydrating with a fluid tinged with the same dye used in staining the bacteria (No. XIII.).

Kuehne advises spreading differentiated sections of glanders material upon the cover-glass, blowing them dry (*cf.* p. 585), laying the cover-glass (with the section upward) upon a glass plate, where it is slightly warmed, not to exceed 30° C., over a spirit lamp, until the section becomes transparent, when, after lying on the warm plate for five minutes, it is cleared

with ethereal oil and passed through xylol into balsam [so that the use of alcohol is entirely avoided because of its marked decolorizing action on the bacteria].

For the microscopic examination of sections which contain stained bacteria, a sub-stage condenser is used. The Abbé condenser is the most perfect of the various models in use, but the cheaper Dujardin and similar condensers, which are readily used on smaller stands in place of the well-diaphragm, are entirely satisfactory.

Koch first called attention to the importance of the condenser in bacteriological microscopy. By means of this instrument, as he expresses it, it is possible to efface the "structure image" and so to get rid of its disturbing and concealing influence on the "color image." By the former name he designates the image of lines and shadows which reveals to us the structure of the tissue, and which results from diffraction of the rays of light during their passage through the preparation, different parts of which (nuclei, fibres, etc.) differ in refractive power from the substratum in which they lie By the "color image," he refers to the image of colored parts, which, if very small, may be completely concealed by the lines and shadows of the structure image. By the use of an Abbé or similar condenser [with full opening], the preparation is illuminated with so broad a cone of light that the tissue appears as a structureless plane, on which the colored parts, large and small, stand out sharply. It is easy to convince one's self of the great advantage of using such a condenser, for a section which is full of stained bacilli of mouse septicæmia, may appear free from bacteria when examined with ordinary illumination with the concave mirror and diaphragm, while the condenser resolves a mass of colored rods within it.

What is here said of the examination of stained bacteria in sections, is also true of cover-glass preparations, in which the bacteria frequently occur upon or within elements the structure images of which mask them. On the other hand, it must be remembered that the examination of unstained bacteria should always be made without a condenser; with the finest diaphragm which gives sufficient illumination; or, what amounts to the same thing, with the condenser lowered as far as possible.

Methods of Staining Sections.

Several of the numbered methods which follow have already been described for cover-glass preparations, but are repeated here with the changes necessary for sections.

(XI.) *Weigert's Original Method* (1876).—The section is laid for a rather long time in a quite strong solution of methyl violet, washed out in dilute acetic acid, anhydrated in alcohol, cleared in oil of cloves, and mounted in balsam.

Weigert's improved method (1881) employs an aqueous 1-per-cent solution of gentian violet, BR., from which the section goes to absolute alcohol, clove oil, and balsam. (Weigert recommended gentian violet, BR., especially because it is not so easily removed from the bacteria when the section is treated with alcohol and clove oil.)

(XII.) *Loeffler's Potash Blue Method.*—The sections are placed for a few minutes in alkaline methylene blue (No. 10), differentiated for some seconds in 0.5-per-cent acetic acid, anhydrated in alcohol, cleared with cedar-oil, and mounted in balsam.

(XIII.) *Kuehne Universal Method.*[8]—The section is laid in carbolic methylene blue (No. 6), as a general thing for half an hour (but for leprosy, two hours), rinsed with distilled water, treated with dilute hydrochloric acid (No. 12) until the color is pale blue, rinsed in lithium-water (No. 14), laid in distilled water for some minutes, dipped for anhydration into absolute alcohol (which may be colored with methylene blue, p. 590), before it goes into a salt-cellar of aniline-oil colored with methylene blue, where in a few moments it becomes anhydrated without being decolorized, then rinsed in pure aniline oil, cleared in turpentine, and when all aniline oil has been carefully removed by treatment with xylol, usually renewed once, it is mounted in balsam. When the aniline oil is not completely removed, the balsam becomes brown with time.

The differentiation in hydrochloric acid is the most difficult point in the process. Thin sections need only be dipped into it; and in any case a sharp watch must be kept upon the degree to which decolorization has progressed, so that the section may be rinsed in lithium water at once when the right shade is reached.

(XIV.) *Koch's Isolated Staining Method.*—After staining in an aqueous solution of fuchsin, methyl violet, or methylene blue, the sections are washed out in a half saturated solution of carbonate of potassium (No. 15 *a*), then passed through alcohol, xylol, and balsam. Weigert was the first to undertake an isolated staining of bacteria in tissues, since by the use of carmine, followed by washing in glycerin acidulated with hydrochloric acid, he stained clusters of micrococci in 1871.

Malassez and Vignal, after staining in methylene blue, wash in No. 15 *b*, etc.

(XV.) *The Gram Method.*—The sections are transferred directly from absolute alcohol into aniline gentian violet, and treated like cover-glass preparations (No. III.), except that they are anhydrated in absolute alcohol and cleared in cedar-oil preparatory to being mounted in balsam. For Weigert's modification of the method, see No. XIX., *infra.*

When sections stained by this method are also treated with a nuclear stain like carmine, a very pretty double staining is obtained. Fraenkel recommends the following method, which is also thought to more frequently escape the troublesome granular precipitates which now and then appear in the preparation when the original Gram method is used.

(XVI.) The sections are transferred from alcohol to strong picro-carmine, where they remain half an hour, are rinsed in 50-per-cent alcohol, then go for half an hour into unsaturated aniline gentian violet—prepared by dropping a few drops of the saturated alcoholic solution (No. 1) into a watch-glass containing aniline water (No. 5) until the mixture begins to be opaque—from which they are placed directly in the iodine water for three minutes, then into alcohol, where the red color reappears and they become anhydrated, when they go through cedar-oil into balsam.

(XVII.) *Koch-Ehrlich-Weigert's Tubercle Method.*—The sections are laid in aniline gentian violet (No. 9) for twelve hours, moved about for a few seconds in 25-per-cent nitric acid, rinsed in 60-per-cent alcohol until they show only a slight blue color, counter-stained for some minutes in a saturated aqueous solution of vesuvin, rinsed in 60-per-cent alcohol, anhydrated in absolute alcohol, cleared with cedar-oil, and mounted in xylol balsam.

The tubercle bacilli are also stained by Kuehne's method

(XIII.) and the Gram method, but where a differential diagnosis is required decolorization must be effected by strong mineral acids (*e.g.*, as in Nos. XVII. and XVIII.); for it is its resistance to decolorization by mineral acids which distinguishes the tubercle bacillus from all other known species except the bacillus of leprosy, which, however, differs from it in staining readily with a simple aqueous solution of methyl violet or fuchsin. The so-called smegma-bacilli also show a decided power to resist the action of mineral acids, but they are readily decolorized by subsequent treatment with alcohol, which is not the case with either the tubercle or leprosy bacillus. The smegma-bacilli are probably only different species of putrefactive bacteria which, from growing in the smegma, have become so impregnated with oily matters that they have become difficult to stain. This view is supported by the fact that it has proved possible to change the behavior of other species toward staining methods, by growing them in substances containing butter, etc. (Bienstock). On the other hand, the diagnosis of smegma-bacilli may be attended with some difficulty as compared with Lustgarten's syphilis bacillus, the etiological relation of which to the disease is still very problematical, although it has been demonstrated in syphilitic secretions and neoplastic growths. Like the syphilis bacillus, after being stained on the cover-glass for twenty-four hours in aniline gentian violet, they remain colored after treatment for ten seconds with 1.5-per-cent solution of potassium permanganate, followed by sufficient washing in sulphurous-acid water to entirely decolorize the preparation. The syphilis bacillus cannot be confounded with that of tubercle, because it is very easily decolorized by mineral acids.

(XVIII.) *Ziehl-Neelsen Tubercle Method.*—Sections are more rapidly stained by laying them for fifteen minutes in carbolic fuchsin (No. 7), agitating them a few seconds in 25-per-cent sulphuric or nitric acid, rinsing in 60-per-cent alcohol until only a light rosy color remains, counter-staining for some minutes in a saturated aqueous solution of methylene blue, and rinsing, anhydrating, and mounting as before.

For staining bacteria in sections of hardened gelatin-cultures, see Neisser, "Centralbl. f. Bakteriologie," 1888, III., 506.

Moulds.

The following notes on mounting moulds refer chiefly to the directions of O. Johan-Olsen.

Temporary preparations are obtained by laying the mould for a few minutes in dilute alcohol, then in weak ammonia, which is removed with filter-paper, the surplus washed out with water, and this replaced by glycerin, in which the examination is made.

Permanent preparations are made in the same manner, after staining the material in osmic acid, which is kept for use in a 0.5-per-cent solution in a dropping-bottle that has been well cleansed with alcohol and ether and is stopped with glass. Two drops of this are added to eight drops of water in a watch-glass (*i.e.*, about 0.1 per cent), in which the mould is allowed to lie for an entire day; or, if the 0.5-per-cent solution is used directly, a few minutes suffice. The preparation is then washed with alcohol, followed by distilled water. If it is still too black, it is decolorized sufficiently in weak ammonia, followed by water, and mounted in glycerin. Preparations stained with osmic acid may also be further stained by saffranin, usually a very dilute solution, in which they are allowed to remain for a long time.

Preparations of an entire culture can be made upon the slide. Usually the cultures are obtained from fluid media (*e.g.*, Brefeld's slide-cultures, *supra*, p. 539), and those which are not too far advanced are chosen. The colony being placed on a slide, a cover-glass is let down upon it carefully—especially in case of the erect forms—and it is allowed to dry down so that the cover-glass does not move around (usually only a few minutes being needed), when 0.1-per-cent osmic acid is added at one side and drawn under by applying bibulous paper to the other edge of the cover. After a proper time the acid is thoroughly washed out with water that is drawn under the cover in the same way, and, either with or without saffranin staining, mounted by drawing glycerin under and sealing in the usual way; or else dilute alcohol is used instead of the osmic acid, and followed by ammonia, etc., as indicated above for temporary preparations.

For demonstrating moulds in sections, Hueppe recommends

the methylene blue universal method (Nos. XII. and XIII.). Hibbert advises the following modification of the Gram method:

(XIX.) *Weigert's Fibrin Stain.*—The section hardened in alcohol is stained for a long time in saturated aniline gentian violet (No. 9), rinsed in 0.7-per-cent solution of table salt, and transferred to the slide, where the other steps are taken. The superfluous water is removed with filter-paper, iodine water (No. 16) is dropped upon it and removed with filter paper, and a couple of drops of aniline oil allowed to fall upon the section for the purpose of at once decolorizing and anhydrating it.

As the aniline oil soon becomes dark, it must be removed and replaced by fresh oil once or twice, after which it is entirely replaced by xylol and the section mounted in balsam.

Actinomyces.

When it is only desired to obtain a sure diagnosis of *Actinomyces* colonies in pus or sections, treatment with acetic acid, glycerin and examination in glycerin suffices. For cover-glass preparations, Fraenkel employs the Gram method, letting the section stay in aniline gentian violet for twenty-four hours, and in the iodine solution for fifteen minutes. The Weigert-Gram method (No. XIX.) appears suited for staining sections for *Actinomyces*.

Amœboids.

The amœbæ or amœboid organism detected by Laveran and subsequently more fully studied by Marchiafava and Celli, Golgi and others, and held to be the cause of malaria, are susceptible to staining by any of the above methods. It is, however, possible, when cover-glass preparations of the blood are stained with methylene blue or vesuvin, to find within the red blood-corpuscles larger or smaller irregular spots, colored blue (Marchiafava and Celli). These are the stained parasites. But a clear view of all the developmental forms of the amœboids is obtained only by examination of the fresh blood. Laveran gives the following directions for this: The parasites are most easily found in patients already anæmic, and who have not been taking quinine, at any rate just before the exam-

ination. The blood is obtained just before, or in the beginning of an attack, by a needle puncture in the finger-tip or lobe of the ear, after careful cleansing with water and alcohol. The surface of the drop which exudes is touched with a well-cleaned slide, and the small drop of blood which adheres is quickly covered with a cover-glass, and sealed with paraffin when the layer of blood is thin enough for examination. An enlargement of 400 to 500 diameters is sufficient for the investigation, places being chosen where the red corpuscles lie flat and isolated. Few parasites are usually to be seen, rarely as many as eight to fifteen in the same field, so that one must be prepared to spend some time in searching for them. The pigment granules that occur in most of the amœbæ give a clue in the search. Richard recommends the addition of a drop of dilute acetic acid for the rapid demonstration of these parasites, as it removes the annoying red blood-corpuscles without destroying the parasites. According to Laveran, the addition of water is better, as it does not kill the amœbæ so soon as acetic acid does, but allows them to continue their peculiar movements.

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A PRACTICAL

TREATISE ON BALDNESS.

BY

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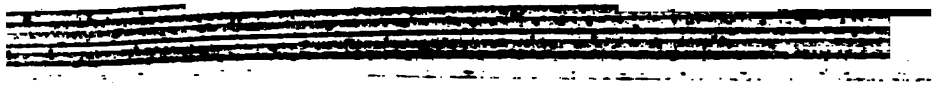

A PRACTICAL TREATISE ON BALDNESS.

PREFACE.

MOST people object to being bald. Quite often unmarried men say that they would not mind having their hair fall out if only it could be delayed until after they were married. The logic of this is somewhat obscure. Many persons look upon baldness as a sign of advancing years and would fain stay its progress on that account. Others complain of taking cold because the head is deficient in its natural covering, which compels them to wear a silk cap or a wig. It is not to be wondered at that women should fear the onset of baldness, as fine, abundant hair is an ornament to a woman, something that she herself takes pride in, and that calls forth admiration from all. Therefore, even if baldness does not incapacitate a man or woman from work or from pleasure, and is, in most cases, a matter of really very little importance; yet inasmuch as there are a host of our fellow-men, and perhaps even of ourselves, to whom the matter seems of considerable importance, it behooves us to consider the varieties of baldness and the causes of the same; and to learn how much we can do to prevent the destruction of the hair follicles and the final disappearance of the hair. The word "prevent" is used designedly, for I believe that the preventive treatment of baldness is of manifold more importance than any curative treatment.

ALOPECIA.

The term alopecia is derived from the Greek ἀλώπηξ, meaning a fox, because of its resemblance to the appearance presented in the "fox mange."

Synonyms.[1]—Capillorum defluvium; Athrix depilis; Pha-

indicate that a disturbance in nerve supply was at the bottom of both diseases. Hairless races of men have been reported.

Pathology.—The cause of the disease is an arrest of development of the hair, probably dependent upon some error in innervation. It is said to be hereditary in some families. Infrequent opportunities have offered for the study of the disease by the microscope, but these have shown a deficiency of the hair follicle. Jones and Atkins[2] reported a case in 1875 in which microscopical sections of the scalp of a boy who never had hair showed only a few aborted hair-follicles, forming shallow pits in the epidermis with open extremities looking downward. Schede, in 1872, reported two cases,[3] a brother and sister, thirteen and six years old respectively. Microscopical examination of sections of the boy's scalp revealed well-developed sebaceous glands emptying directly upon the scalp. In the neighborhood of some of them and just above their lower extremity, were found a great number of "atheromas," separated from the glands by connective tissue, and apparently developed in a species of short tubes. In structure they resembled that of the outer root-sheath of the hair. They were probably rudimentary hairs. Hutchinson[4] has reported a case of congenital absence of hair in a boy three and a half years old, in which there was a withered, atrophic condition of the whole integument and an absence of nipples. The mother of the child had been almost wholly bald from chronic alopecia areata dating from the sixth year of her age.

Treatment.—We can do but little in the way of treatment directed to the scalp to remedy this deformity. The best we can do is to care for the general nutrition of the child, and the hygiene of the scalp. Happily in most cases nature effects a cure, and the hair grows of itself. We can assure the parents that the probability is that the hair will grow after a time, though the growth may never be as full as is usual. These children often grow into "thin-haired" adults. Expectant treatment is that which we should employ, merely keeping the scalp free from accumulations of sebaceous matter by means of oily inunctions. The oil, such as oil of ergot, castor oil, or olive oil, may be used either by itself or medicated with sulphur, say twenty or thirty grains to the ounce. The scalp should be washed every few days with soap and water, the

utmost gentleness being practised. Should this expectant plan not satisfy the family and friends, then recourse may be had to some of the stimulating hair washes given in our section upon Alopecia presenilis. If a lichen pilaris condition of the scalp is present, then washing with the tincture of green soap, and inunctions with oil, will serve to remove the accumulations of sebaceous matter plugging up the follicles and give the hair a chance to grow.

Alopecia Senilis.

This is the baldness that occurs with advancing years and is but a part of that general atrophy or decay that marks the lowering of vitality incident to the period. To place the time exactly, and thus to mark the onset of old age, is difficult. For convenience the period of man's prime is placed usually at from the forty-fifth to the fiftieth year of his life, and after that he is said to be growing old. It is customary, then, to regard a case of baldness beginning at about this time as one of the senile form. It is often preceded or accompanied by graying of the hair. Sometimes the hair turns gray five years or more before it begins to fall, and it should always be regarded in a man of middle life as a premonitory symptom of baldness. On the other hand, the hair may fall without becoming gray. When this form of baldness begins it is progressive, though its rate of progress varies greatly. Careful examination of the scalp shows, in most cases, no abnormality. In some cases there may be found a slight seborrhœa sicca. It begins, in the great majority of cases, upon the vertex, forming the tonsure, and spreading from there forward and downward. It may begin anteriorly and spread backward, or affect the whole top of the head at once. When complete the hair is absent from the whole top of the head, and posteriorly to just where the hat-band usually rests, or a little below that point, that is from over the region of the aponeurosis of the occipito-frontalis muscle. It is always symmetrical. The bare scalp is smooth, oily, shiny, and appears stretched.

While this form of baldness most commonly affects the scalp alone, it invades the other hairy parts at times. The hair may fall from the pubis and axillæ, and even from the beard. The beard is very exceptionally affected. Statistics

are wanting, but my impression is that senile baldness of the pubic region and of the axillæ is more common in women than in men.

Senile baldness, like premature baldness, affects men more frequently than women, though the latter become more often bald than we give them credit for. In our times wigs have very much gone out of fashion for men's wear, and when a man is bald, we know it. Women can more readily conceal their baldness by the arrangement of their hair, and do not hesitate about employing the wig maker.

Pathology.—In this form of baldness there is a gradual sclerosis of the subcutaneous tissues of the scalp, the retrograde process beginning in the arterial supply to the scalp in the form of a fibrous endarteritis which narrows the lumen of the cutaneous arteries, and finally obliterates the capillary circulation about the hair follicles. The subcutaneous fat disappears, and the meshes of the connective tissue become smaller. An absolute atrophy of the scalp results. Neumann shows that the part involved both in this and premature baldness corresponds quite nearly to that supplied by both supra-orbital nerves; and in very extended cases the regions supplied by the temporal and the occipitalis major and minor nerves are also involved.

Treatment.—Our only hope is to delay the progress of the disease. There is no such thing as a cure for Alopecia senilis. Prophylaxis is along the lines laid down in the next section when writing of the hygiene of the scalp. When the scalp is atrophied we can do nothing.

Prognosis.—In any event the prognosis of a case is bad. As quite exceptional incidents may be mentioned the growth of a new crop of hair upon the bald heads of aged people, along with the eruption of new teeth in their toothless gums. Such events are so very rare that they need not be counted on in our prognosis.

Alopecia Prematura.

We now have to consider that form of baldness which most interests us, both as individuals and as physicians. It is not only the form which embraces the greatest number of cases, but also the one in which we can obtain results as the

reward of our efforts. While in alopecia adnata and in alopecia areata we have to trust in large measure to the healing powers of nature, in alopecia prematura we can often greatly aid nature by the practice of our art. By alopecia prematura we mean baldness occurring before the forty-fifth year. Here again we meet with a purely arbitrary line of division, just as we did in alopecia senilis. We should not hold this line as a hard and fast one, for there are some people whose general condition at forty is such as to entitle them to be regarded as old. Indeed it is rather from the standpoint of prognosis that the division is useful, the chances of recovering the lost hair being a good deal better in those under forty-five than in those over that age.

There are two varieties of premature baldness, namely: alopecia prematura idiopathica, and alopecia prematura symptomatica.

Idiopathic premature baldness is that variety of baldness that occurs before the forty-fifth year of age, and arises without any apparent disease of the scalp or of the individual. The advent of the hair fall is usually early; most of the cases begin between the ages of twenty-five and thirty-five. In its course it greatly resembles the senile form. It begins either at the vertex and forms the tonsure, and from there moves forward; or it begins anteriorly and moves backward, the hair first falling from the temples, and thus giving the individual a high forehead and an intellectual appearance. Or the hair over the whole top of the head becomes thin. In some cases a little tuft of hair in the middle line and just above the forehead will be preserved a long time after the whole top of the head is bald. When fully developed the bald area extends from the forehead anteriorly, to just below where the hat-band comes posteriorly; and from the upper edge of the temporal muscle of one side, to the corresponding point on the other side. It rarely goes beyond these boundaries, and very rarely are the other hairy regions of the body affected.

In women who part the hair in the middle the first thing that attracts their attention to their loss of hair is that the hair in the part is growing thin. If the progress of a case is watched it will be found that the process is one of gradual atrophy, the original vigorous hairs when they fall being replaced by those of less vigorous growth, and this substitution

of weaker for stronger hairs continuing until only lanugo hairs are produced. After a time these too fall and the scalp is absolutely bald. Examination of the scalp shows nothing except the loss of hair, and in some cases an apparent tightening of the scalp upon the underlying bones. The healthy scalp is freely movable upon the skull, and in women and young people there is an appreciable fatty cushion under it. In those whose hair is falling the fatty cushion is entirely wanting, and not infrequently the scalp is hide-bound. Once begun the progress of the hair fall is steadily from bad to worse. The length of time that may elapse between the onset of the diminution of the hair and absolute baldness is not determined with exactness. In some people the process may take years, and in others a much shorter time. It will be seen from this that senile and presenile baldness resemble each other very closely in their symptoms. The difference between them is mainly in the absence of all other senile changes in the latter.

Etiology.—Many reasons have been advanced to account for this variety of baldness, but the most substantial one is heredity. The inherited tendency to hair fall will be found in most cases. It is no uncommon thing to find the fathers and sons of certain families bald at an early age. Such a family trait should be expected quite as much as that of the resemblance of the features, voice, and gestures, concerning which there is no doubt.

Pincus[5] says that there are but two predisposing causes of premature baldness, and those are inheritance and a chronic eczema or impetiginous eruption on the scalp in the years preceding puberty. Of these he regards the latter as the most frequent, as it is often connected with symptoms of relative or absolute debility. Another predisposing cause is insufficient or improper attention to the care of the scalp. The rules of the hygiene of the scalp should be closely followed by those especially who are hereditarily inclined to baldness. What the hygiene of the scalp consists in will be detailed under the section on treatment. The daily sousing of the head with water combined with improper drying of the hair afterward, is probably an exciting cause of baldness. Ellinger[6] has noted this habit in eighty-five per cent of the cases of baldness that have come under his observation. Sweating of the head,

whether spontaneous or induced by the wearing of unventilated and hot head gear, is believed to be another exciting cause. A certain number of those who are bald will complain of sweating and heat of the head, whether it is covered or uncovered. Temporary residence at the sea-side, particularly when combined with sea bathing, will hasten the fall of hair when begun. Constant mental strain seems to be an active factor in premature baldness. This is but another way of saying that heat of the head produces baldness. In active brain work the circulation of the head is increased, and the scalp sympathizes with it and becomes warmer. Eaton[1] found by actual counting of heads that baldness was more common in the intellectual and educated classes than in those who were uneducated. In the audiences attendant upon the opera and the churches of Boston from 40 to 45 per cent of the men were bald; while the percentage was only 12 to 25 in the crowds visiting cheap museums and prize fights. Jamieson would account for the loss of hair following upon cerebral excitement by the anatomy of the nerves distributed to the scalp, which he says are directly connected with those distributed to the pia and dura mater. The continuous wearing of a hat, especially a stiff one, has been long reputed as an exciting cause of baldness. It is argued that the unyielding hat interferes with the proper nutrition of the scalp by pressure upon the arteries that supply it, namely the anterior temporal in front and the occipital and posterior temporal behind, and that the preservation of the little tuft of hair in front is owing to the fact that it is nourished by the two supraorbital arteries, which escape pressure by lying in slight concavities between the frontal eminences. The presence of this tuft may better be accounted for by its receiving better nourishment than the rest of the affected scalp, as it lies over the belly of the occipito-frontalis muscle and not over its tendon. An ingenious theory is advanced by Jamieson as a reason why the wearing of hats produces baldness, namely: "that it is a natural law that any organ the use of which no longer exists and whose function is imperfectly filled or the performance of which is perverted, is apt to waste. Hair performs the office of protecting the scalp from injury and blows. When covered, the necessity for this protection is removed, and the hair atrophies and withers. At the same time it is deprived of the stimulus of the sun and air,

and therefore dwindles and pines away." The strongest part of this theory is the last part. The hair needs light and air for its proper luxuriant growth. The boys of Christ's Hospital of London, the Blue Coat boys, are noted for their remarkably thick growth of hair, and a similar growth is found in men leading an out-of-door life. Hardy regards the gouty vice as a predisposing cause. Pincus[8] says that all forms of baldness are due either to primary or secondary induration of the scalp; and that some of the causes of primary induration are the action of cold, as by an ice bag; gleet; leucorrhœa; and great depression of spirits or anxiety of mind against which the patient struggles.

Women less often become bald than men do. Some reasons for this are as follows: In them the fatty cushion under the scalp is preserved for a long period. They give more attention, as a rule, to the care of the hair. Their hats do anything but press upon the head and protect the hair from air and sunlight. They generally keep water away from their hair as carefully as a cat avoids stepping into the water. It is thought by some that as they are covered with hair to a less extent than are men, they therefore have more hair-forming materials to put at the disposal of the scalp. This would indicate such poor work on nature's part that it is not worthy of serious consideration.

Pathology.—The process is one of progressive induration of the connective tissue under the aponeurosis of the occipito-frontalis muscle, the meshes of which, becoming lessened in size, gradually draw the scalp down upon the underlying tissues. The hair papillæ becoming more and more pressed upon are at first lessened in diameter and at last completely obliterated.[9]

Treatment.—In the treatment of alopecia prematura prophylaxis is of more importance than the best directed efforts to restore the lost hairs. If we could impress this fact upon the laity, and induce those who are bald themselves or come of families in which loss of hair occurs early, and who are at the same time parents, to place their children's heads under early and continuous medical care we could do much to prevent that "Bald and Toothless Future" of which we have heard.

Prophylaxis should be begun at the beginning of life and continued until its end, or until such time as it may seem no

longer necessary. It concerns itself with the hygiene of the scalp. The scalp of the infant should be cleansed gently of the vernix caseosa and the extraneous substances it has gathered during the process of parturition. For this soap and warm water and a soft cloth should be used. Then the scalp should be dried by gentle patting with a soft and warm cloth, and then oiled with sweet almond or olive oil. After the first thorough washing the scalp should not be washed more than two or three times a week, but it should be oiled daily. As the hair begins to grow only a soft brush should be used to arrange it, and the oiling should be stopped. Any accumulations of fatty matter should be removed by oily inunctions, or to the oil some medicament should be added, should the case prove obstinate. The slightest indication of disease of the scalp should be properly handled, and the nutrition of the child should be carefully watched over. The child's hair should be kept cut short, but by this is not meant that it should be cropped off close to the head. A girl's hair should be allowed to grow after she has reached her eighth or ninth year, because that will assure her finer hair than if it is cut until a later period of life. From the period of childhood on through life, shampooing of the scalp should be practised not oftener than once every two or three weeks. For washing the head any good soap may be used with warm water, the suds being washed out, and some oil or vaseline applied after drying. Borax and water cleans nicely, and if used at long intervals will do no harm. Soap bark makes a pleasant shampoo. The yolk of three eggs beaten up with a pint of lime water is another pleasant shampoo that is non-irritating. Sousing of the head with water every morning should not be allowed, unless the hair is carefully dried and some oil is applied to it to take the place of the oil that has been removed.

The hair should be brushed and combed daily. The brush should have long bristles, set in clumps wide apart, and the bristles in each clump should be of uneven lengths. They should be stiff enough to reach through the hair, but not so stiff as to irritate the scalp. The comb should have large teeth set wide apart and they should have perfectly smooth surfaces and well-rounded ends. Once a day the hair should be brushed until the scalp feels warm. For men it is well to advise that the brushing and combing should be done at the

same time, first a stroke of the comb and then of the brush. For women this is impracticable. They should first comb the hair to open it up to the air, and then brush it for stimulation. If the hair is thoroughly brushed and combed daily there will be no need for using any oil as a "dressing."

The scalp should be kept free from all hair pomades, as they easily turn rancid and tend to clog up the pores of the skin. Moreover they are unnecessary if the hair is properly brushed. The hair should be exposed as much as possible to the air. If the occupation of the individual is such that it is necessary for him to wear a hat more or less constantly, then he should wear a soft, light, well-ventilated hat. As the English people wear stiff hats more than we do, and do not suffer any more than we do from loss of hair, it does not seem probable that the wearing of stiff hats does cause baldness. Still as soft hats do not constrict the head so much as stiff ones, it is well to give the head the benefit of the doubt. Working under hot artificial light should be avoided. Have the light high up. The heat from some of our new patent lamp burners is intense, and must sweat the head more or less. Women should not wear false hair, as that also tends to sweat the head. They should not pull the hair into positions contrary to that in which it naturally grows, nor should they burn it with curling irons, or pinch it with curl papers. The most hygienic way for them to wear the hair is combed straight back or parted on top, and gathered into a loose braid or curl at the back. In both sexes the general health of the individual is to be kept at as high a standard as possible.

By carrying out these rules for the hygiene of the scalp it is possible either to prevent the onset of baldness, or at least to delay it for a season. Even when the hair begins to fall the hygiene of the scalp should be continued, and the general condition of the patient should be carefully inquired into with the view of correcting anything that may be wrong. We can do more for these cases in this way than by using so-called hair remedies. Should the hygienic rules not have been previously put in force, this should at once be done.

The number of hair "tonics," "invigorators," "restorers," and the like that have been placed and are now placed on the market is very great. They gain what little reputation they enjoy mainly from their having been used in the symptomatic

form of premature baldness. The only thing that can be done in the idiopathic form is to avoid doing harm, to use a mild stimulant, and to keep the scalp in a good condition. These indications are fulfilled by following out the rules of the hygiene of the scalp. Still it is necessary to prescribe some wash, oil, or ointment to obtain a little more stimulation in certain cases, and in order to give us a chance to exercise choice and to change from time to time the following suggestions are given.

Anderson recommends the use of tar internally, from two or three drops up to half a drachm of the following mixture being taken three times a day.

℞ Picis liquidæ opt., ... ℥i.
Spt. rectificati, ... ℥i.
M.

The smaller dose is first to be administered, and gradually increased.

Hardy places most reliance upon a pomade composed of beef marrow, 60 parts; castor oil, 30 parts; and gallic acid, 3 parts.

Pilocarpine has been reported by some to cause the hair to grow even upon bald heads, hypodermics being employed. I have had no experience with this method. The jaborandi pomade mentioned under alopecia areata has not given satisfactory results in premature baldness. Still it is worth while to try this drug in appropriate cases. Jaborandi certainly increases the cutaneous circulation, and it would therefore seem rational to suppose that in some cases of baldness due to malnutrition of the papillæ, it might do good. Lassar[10] recommends its use in either one of the two following ointments:

℞ Hydrochlorate of pilocarpine, . . 30 grains.
Vaselin, ... 5 drachms.
Lanolin, ... 2 ounces.
Oil of lavender, ... 25 drops.
M

Or,

℞ Hydrochlorate of pilocarpine, . 30 grains.
Hydrochlorate of quinine, . . 1 drachm.
Precipitated sulphur, . . . 2½ drachms.
Balsam of Peru, ... 5 drachms.
Ox marrow, ... 3 ounces.
M.

Pincus[11] advises, in acute cases, that all stimulating remedies be abstained from, and that the patient's diet and habits of life be regulated so that both shall be of the least exciting kind. He directs the application to the scalp of a two-per-cent solution of bicarbonate of soda, about one or two tablespoonfuls of it being sopped on for two to five minutes with a soft hair brush or sponge. After using this for two to four days, an interval of equal length should be taken, during which nothing is to be applied to the scalp excepting a little oil on the first and second day. After a year's use of the soda, stronger remedies should be resorted to if the hair is still falling.

Galvanism and massage are two agencies for good. They need not be repeated more than twice a week. It probably does not make much difference whether the ascending or descending current is employed or what forn of electrode we use. A metallic roller electrode will be found convenient, the current from ten or twelve cells being allowed to pass for three to five minutes. Massage of the scalp commends itself as a rational procedure. It is well spoken of, and worthy of trial. As we will have occasion to speak of a number of stimulating remedies for use on the scalp in the section upon symptomatic premature alopecia we will not give them here.

Prognosis.—The prognosis of idiopathic premature baldness is not good. It is founded on several factors. In the first place, if the patient comes of a family in which baldness is a marked trait, it is worse than when the contrary obtains. In the second place comes age. If the patient is under thirty and will devote sufficient time to the care of his hair, it is possible to do something for the case. If, on the other hand, the patient is in the forties, there is not much hope for us to do anything except, perhaps, to check the fall for a season. In the third place we have the rate of hair fall. Should we find by counting the hair that falls, that the uncut hairs in a man or the hairs under six inches long in a woman form more than one quarter of the whole number of fallen hairs, the prognosis is bad, and unless we can reduce these proportions, the disease is progressive. To count the hairs, a very tedious process, the patient should gather all the hair that falls for three successive days, each day by itself. Then each day's fall is to be counted, and the proportions ascertained. After a

month or six weeks the same counting is to be repeated. Another method of ascertaining the progress of the case is proposed by Unna.[12] It is that the fallen hair be gathered into a little bundle with the roots all one way, so that their condition may be readily seen. So long as the fall is rapid many hairs will be found which have just past the papilla stage, whose knob-like roots are still long and are often furnished with an elongated epithelial projection. The less the fall is the fewer of these roots will be found, till only the rounded full roots are met with, showing that the hair has reached full maturity, and therefore has not been prematurely shed.

Alopecia Prematura Symptomatica.

Having considered premature baldness arising without any apparent disease of the scalp or of the general economy, we now pass on to the study of premature baldness in which some disease of the scalp, or some general malady may be assigned as a cause. Apart from etiology this form of premature baldness is almost identical with that just described. It has four varieties, namely: 1. Alopecia furfuracea seu pityroides; 2. Alopecia syphilitica; 3. Defluvium capillorum, and 4, Alopecia follicularis.

1. *Alopecia furfuracea seu pityroides.*—This is the form most frequently met with, and the one in which we can obtain, ofttimes, good results directly by our treatment. As its name indicates it is complicated with and is due to a seborrhœa or pityriasis of the scalp. It is very important that it should be recognized that dandruff may give rise to baldness, as thus it will be considered to be worth while to give attention to the former in order to prevent the latter.

There is a difference between seborrhœa sicca and pityriasis, though both are commonly spoken of under the name of dandruff. By seborrhœa sicca is meant an accumulation upon the scalp of sebaceous matter forming more or less abundant and thick grayish fatty plates, that may be picked off of the scalp and that may mat the hair together. Usually the scalp will be pale in color when the sebaceous matter is removed. At times it will be somewhat reddened. Pityriasis capitis constitutes that form of dandruff in which the scalp is found to be covered with thin, easily detachable scales, that fly off from

the scalp and fall upon the coat collar like snow. The scalp may show no change in color or it may be a little redder than normal. By some, notably Unna of Hamburg, both forms are regarded as varieties of eczema, and have been named eczema seborrhoicum. The supporters of this view believe that the sebaceous glands have nothing to do with the disease. Whether they are right or not is not yet determined. Happily it makes no difference as far as the patient is concerned.

Alopecia pityroides has two stages. The first or premonitory stage continues for some two to seven years and is marked by the presence of a greater or lesser amount of dandruff, and by dryness of the hair. The second stage then follows, when to the dandruff is added a more or less rapid loss of hair. In this form of baldness the whole top of the head is more frequently affected from the beginning than in the preceding form, though it may follow exactly the same course. The hair is dry, and becomes progressively thinner in diameter and less in amount until absolute baldness results. The dandruff is present until there is a marked diminution of the hair, when it decreases, and finally disappears as baldness is pronounced. The scalp is usually itchy at times, especially when the head is hot, as when sitting under a hot artificial light. The baldness does not exceed the limits occupied by the idiopathic form.

This variety of baldness usually begins quite early in life, somewhere between the twentieth and thirtieth year, and affects both sexes. Indeed it is said to be more frequent in women than in men, though less persistent. My own experience does not accord with this, as I have had nearly twice as many men as women with it.

Etiology.—The cause of this variety of baldness is the accompanying seborrhœa or pityriasis. This was accepted without question until Malassez [13] and Chincholle [14] in 1874 declared their belief that the disease was due to a parasite, which they described. Bizzozero [15] has shown, more recently, that spores identical with those of Malassez and Chincholle are found quite generally upon the normal human scalp. Lassar and Bishop [16] believe that the disease is contagious and is frequently transmitted by brushes and combs, especially those of barbers. They would explain the comparative immunity of women by the fact that they are less exposed than

men at the hands of the barber. They found that it was possible to produce baldness upon Guinea-pigs by rubbing into their backs a pomade composed of the scales taken from the scalp of a man who was losing his hair on account of dandruff, rubbed up with vaseline. The baldness was produced in other Guinea-pigs and rabbits by rubbing into their backs a pomade of the scales from the first Guinea-pig's back. This experiment should be repeated. Of late years the opinion is gaining ground that alopecia pityroides is contagious, and due to a micro-organism. Thus far no specific organism has been found.

Whether the dandruff that causes the loss of hair is a seborrhœa, a pityriasis, or a seborrhœal eczema; whether it is due to a parasite and contagious or not; the fact that interests us most is that a certain condition of the scalp which we have been accustomed, for a long time, to call dandruff, does cause one form of baldness. All conditions, therefore, that produce dandruff may cause baldness. But dandruff does not necessarily cause baldness. Those people who naturally have very vigorous hair often escape becoming bald on account of the resistance their hair offers to the conditions producing it in less fortunate subjects.

Pathology.—The pathology of seborrhœa sicca is simple. It is a functional derangement of the sebaceous glands on account of which, instead of the normal oily secretion being formed, the transformation of the lining cells of the glands stops a little short of completion, and a more consistent fat is produced. On account of this the hair is not furnished with its proper lubricant and becomes dry. As is well known the sebaceous glands communicate with the upper part of the hair follicle, and it is probable, therefore, that any disturbance of the former will be sympathized in by the latter. In seborrhœa sicca there is an error in the nutrition of the sebaceous glands, and after a time the hair follicles likewise show an interference in their nutrition by the hairs becoming too early loosened from their papillæ and cast off. In the course of years the papillæ become atrophied, can produce no more hair, and permanent baldness becomes established. The normal life of a hair is from three months to a year.

In alopecia, as already noted, there is a marked increase in the number of young, immature hairs shed. The proportion

between them and the fully formed mature hairs that fall is much greater than in the normal state. As the papillæ lessen in diameter the hairs they produce become progressively thinner, and as they are earlier cast off than they should be, they do not attain to their normal length.

The supporters of the parasitic theory of the disease believe that the parasite attacks the hair follicles, as well as the scalp. Thus Malassez says: "The parasite causes an irritation of the follicular walls, followed by their hypertrophy. This closes the cavity of the follicle, causes a fibrous transformation of its walls, and finally a fall of the hair." Malassez described what he regarded as the parasite causing these alterations as "constituted of spores without tubes of mycelium, generally oval in shape, seldom spherical, and very small. It inhabits the corneous layer of the skin, and penetrates the follicles, but does not reach the orifice of the sebaceous glands." As this micro-organism has been found to be very commonly present on the normal scalp, it is highly probable that it is not the cause of baldness, but only a matter of scientific interest.

Treatment.—As in the idiopathic form of premature baldness, so here, prophylaxis is of far more value than is specific treatment. Prophylaxis consists, in the first place, of conformity to the already detailed laws of the hygiene of the scalp. If the general health can be maintained, and the scalp not only kept clean and in vigorous condition, but also protected from harmful influences, dandruff will not form. Should dandruff be found no delay should be allowed until it is subjected to proper treatment. If it is cured or held in check baldness will not supervene. Even if the hair has already begun to fall we must address ourselves to the treatment of the seborrhœa or pityriasis. There is no "hair-grower" known. All that we can do is to keep the scalp in good condition and thus give nature a chance to effect a cure.

If dandruff is present in large amount, so that it forms cakes or a thick, greasy, rather powdery mass throughout the hair, the scalp should be soaked at night with sweet almond or olive oil, and the head enveloped in a towel. The next morning the head is to be thoroughly washed with soap and water. If the dandruff is in less amount we can proceed at once to wash the head. It is well to warn the patient before

he head is washed, that a good deal of hair will fall out with he washing, but that it does not make any difference, as they were hairs ready to fall anyway. If this warning is not given the patient may be alarmed, and the physician blamed. It does not make much difference what soap is used. The tincture of green soap is a convenient one where there is no irritation of the scalp. It forms an excellent lather. It should be used by means of a flannel cloth or sponge which is dipped in the soap and then in the warm water and then rubbed on the scalp. Sarg's liquid glycerin soap is an elegant preparation, and much milder; but hard to find in this country and much more expensive. Pear's glycerin soap, pure castile soap, soap bark or any good toilet soap answer perfectly. Should the scalp be irritable, then it is better to use no soap, but wash the head with a mixture of the yolks of three eggs to a pint of lime water. The vast majority of scalps bear soap without harm. Having removed the crusts or scales the chosen ointment, oil, or lotion is to be applied at once.

Sulphur, according to my experience, should be placed at the head of the list of our remedies in alopecia furfuracea. It exerts a marked curative action in all forms of sebaceous disease, and promotes cornification. The objections to it are that it is but very slightly soluble, and is apt to leave a yellow powdery deposit upon the scalp and hair if carelessly used. It may be exhibited in castor oil, vaseline, lard, or lanolin. The latter substance is a disagreeable one to use; and I have had so many unfortunate experiences with it that I have given it up for use on the scalp. It is a good rule to use no thick ointment as an excipient for remedies to be used on the scalp, as they tend to stick the hair together, and form an unpleasant mess. Whether a perfume shall be used or not for pomades is a matter of individual taste. To return to our sulphur. The strength to be employed is from thirty to sixty grains to the ounce. This should be applied every night for two or three weeks; then the scalp should be washed, and the remedy applied again. Now it should be used every other night, for another period of three weeks; then twice a week, and so taper off, as the case progresses to recovery. The remedy should be applied to the scalp and not to the hair, and there is no need of using great quantities. Any superfluity of grease that may get upon the hair may be removed by a towel moist

ened in cologne water or ether. Should the sulphur irritate the scalp, stop it for a time, use olive or almond oil till the irritation subsides, and then begin again with an application of less strength. This treatment is to be persisted in for a year at least. The precipitated sulphur is the form of sulphur most frequently used, but the washed sulphur will answer equally well.

Mercury is very useful in these cases. A very elegant formula is that of Prof. E. B. Bronson, of the New York Polyclinic, as follows:

℞ Hydrarg. ammon., ... ʒi.
Hydrarg. chlor. mitis, ... ʒij.
Vaselini, ... ℥i.
M.

This will be found of great service in the milder forms of dandruff in which baldness has not begun. It is of the consistence of a Mayonnaise dressing when it is properly made. Naturally mercury is used by those who believe in the parasitic origin of the disease. Lassar claims excellent results from his plan of treatment, which is as follows: The head is to be vigorously washed for ten minutes each day with a tar soap that forms plenty of suds. The suds are to be washed out with warm water followed by cold water, the scalp dried, and anointed with

℞ Solution. hydrarg. bichlor. (0.5 per cent strength),
Glycerini,
Spiritus odorati, ... āā p. æ.
M.

Then the scalp is to be rubbed dry with absolute alcohol containing one half of one per cent of naphthol. Finally the following oil is to be applied:

℞ Salicylic acid, ... ℥ss.
Tincture of benzoin, ... gr. xlv.
Neat's foot oil, ... ℥iij.
M.

This procedure is to be repeated daily for six to eight weeks and then less often. In obstinate cases the mercurial solution is to be used many times a day. As substitutes for this plan of treatment he commends the use of equal parts of oil of turpentine and oil or dilute alcohol, or this:

℞ Carbolic acid, ... gr. xv.
Sublimed sulphur, ... gr. lxv.
Horse-neck fat, ... ʒ ij.
M.

Shoemaker recommends the use of equal parts of oil of ergot and the fluid oleate of mercury scented with the oil of rose or of verbena.

Resorcin may be useful, and is highly commended by some eminent authorities. Three per cent appears to be the preferred strength. Ihle's formula for it is:

℞ Pure resorcin, ... gr. xv.
Castor oil, ... ʒ iiss.
Alcohol, ... ad ʒ i.
Balsam of Peru, ... gtt. ij.
M.

This is to be rubbed into the scalp daily with a piece of flannel. A soap containing an excess of fat and three per cent of resorcin and salicylic acid has recently been most highly extolled by Eichhoff, of Elberfeld (Ueberfettete Resorcinsalicylseife). It seems probable that it would make an agreeable and efficient application for these cases. Tar is one of our best remedies for use on the scalp. The objections to it are its color and odor. Heitzmann, of this city, at one time used it very extensively in the treatment of baldness, and reported some excellent results. He prefers the crude oil of birch, (oleum rusci) in the strength of ten to twenty per cent in an ointment of vaseline and paraffin, with some perfume to cover the smell of the tar. This is to be alternated with sulphur and white-precipitate ointments. A formula of Piffard for the employment of tar is:

℞ Picis liquidæ,
Ol. lavandulæ, ... āā ʒ i.
Ol. pini sylvestris, ... ʒ vi.
M.

Napthol β in five to ten per cent strength, and hydrate of chloral of about the same proportion, are both curative of the scalp affection and therefore helpful in checking the fall of the hair.

When the fall of the hair is pronounced, and the scalp affection has lessened then we need stimulation. From any of the already given preparations we get all the stimulation

we need, and they are the ones most worthy of confidence. The tincture of capsicum, and that of cantharides are much-used stimulants, in the strength of one to three drachms to the ounce of water. The tincture of nux vomica, one drachm to the ounce, is an old war horse. The stronger water of ammonia has likewise been used much. The oils of rosemary and of mace have been credited with curative properties. All these may be used separately or variously combined according to fancy.

Pincus, who has written more than any one about baldness, and is entitled to be heard, advises in the first stage of alopecia furfuracea the use of a solution of bicarbonate of soda strong enough to redden the forehead. This is to be rubbed in thoroughly at night, the head is to be covered with a compress soaked in the solution, and an oiled-silk cap is to be worn over all during the night. This will, unfortunately, discolor the hair. In the second stage, an ointment of eighty grains of tannin to the ounce of rose ointment is to be applied every night, the head being washed every second or third day. He also recommends the following lotion:

℞ Lactic acid, ... ♏ vij.–xv.
Boracic acid, ... gr. xxx.–ʒ i.
Alcohol, ... ℥ i.
Distilled water, . . . ad ℥ viij.
M.

Or this ointment:

℞ Lactic acid, ... ♏ iij.–x.
Boracic acid, ... grs. xxx.–xlv.
Lard or vaseline, . . . ad ℥ i.
Oil of bergamot, ... q. s.
M.

Either of these is to be rubbed into the bald places once or twice a day for two or three weeks, and then, after a pause of a few days, the following:

℞ Bicarbonate of soda, ... gr. x.–xxx.
Lard or vaseline, ... ℥ i.
Oil of bergamot, ... q. s.
M.

is to be used for one week, and the remedies alternated for a year.

So much for local treatment. The subjects of dandruff are usually not in perfect health. The deviation from normal may be very slight, but it is there. The condition of the scalp is apt to grow better and worse as they themselves are in better or worse condition. We should see to it that our patients are reguiar in all their habits, and should be prepared to give tonics, which usually are indicated, or other proper remedy, according to the nature of the case.

Prognosis.—If the patient is a woman and the treatment is begun before the baldness is pronounced, the chances are that the disease may be checked, and that the hair will grow again. The prognosis in regard to men is not so good as to the hair growing again, but we can encourage our patients by the assurance that if they carefully carry out directions they can succeed in keeping what hair they have. If the treatment is begun very early the prognosis is favorable in either sex. If there is a family history showing a tendency to baldness, the prognosis will be rendered so much worse. It is prudent always to tell patients that they cannot expect to see immediate and brilliant results; that the progress is measured by months rather than weeks; and to stipulate for at least one year of patient, careful, and persistent treatment. What was said under prognosis in alopecia prematura idiopathica (page 613) applies also to alopecia prematura symptomatica.

2. *Alopecia Syphilitica.*—Baldness due to syphilis may make its appearance either early or late in the disease, but is met with most often during the early months. It occurs both in benign and malignant cases; more frequently in the latter. It manifests itself in two varieties: a more or less general and temporary variety; and a localized destructive and permanent variety.

It is the first of these that occurs in the early months of the disease. Usually it is but a thinning of the hair. Often there will be disseminated, ragged, irregular bald spots upon the head, giving an appearance similar to what would obtain by taking a rather dull pair of shears and cutting the hair carelessly. Rarely the hair falls from all hairy regions, and the patient is completely bald. Stopping short of complete baldness we not infrequently meet with loss of hair from other regions than the scalp. The broken arch of the eyebrow is characteristic and always suggestive. The eyelashes less fre-

quently suffer. The pubic hair is often affected, especially, according to Fournier, in women. With the hair loss there may be a varying amount of seborrhœa. In the second variety the loss of hair is localized, the patches varying greatly in size from the size of a pea up to a large area. This form of baldness is always preceded by destructive disease of the follicles or of the scalp. The process may be either one of absorption of syphilitic deposit in the follicle or of ulceration. It belongs more properly to what we have termed alopecia follicularis, but is placed here for convenience.

It is said that in inherited syphilis more or less local alopecia is sometimes met with, specially on the fronto-temporal region, and Keyes gives two references in support of this affirmation.

Etiology.—The cause of this form of baldness is syphilis. This, however, acts in two ways in producing the two varieties. In the first variety it is the syphilitic hydræmia and cachexia that causes the hair fall. The nutrition of the hair is interferred with just as in other cachexiæ, and the hair falls in consequence. It is to the same condition that the accompanying seborrhœa is due which further aids in the production of the hair fall. In the second variety it is the deposit of syphilitic material in the scalp, which, either from absorption or ulceration, destroys the hair follicle. It is said that the disease was more common when the use of mercury was abused, and that the mercury was the cause of the disease. But the hair of syphilitics falls quite independently of the administration of mercury.

Diagnosis.—Syphilitic alopecia needs to be diagnosed from idiopathic premature baldness; from alopecia furfuracea, and alopecia areata; and from the alopecia due to favus. If the picture of syphilitic alopecia is once impressed upon the mind, there will be no difficulty in recognizing it again.

It differs from the first two in its irregularity of distribution, in its sudden onset, in the broken arch of the eyebrow, and in its more general involvement of the body. These symptoms should arouse our suspicions, and then we can get some history of the disease.

From alopecia areata it differs in forming bald patches of irregular shape, which are sometimes not completely bald; whereas alopecia areata is characterized by perfectly circular

or oval, entirely bald patches. The history of the two diseases is entirely dissimilar.

The foregoing diagnosis refers to the baldness due to the syphilitic cachexia. That form which is due to destruction of tissue would not be mistaken for any other variety of baldness excepting that due to favus. In both there are irregular patches of baldness with cicatricial tissue. The discovery of syphilitic scars on other parts of the body, and the history of the case will give the diagnosis. Should either disease be in active progress the diagnosis will be easier, the cups and crusts of favus bearing no resemblance to the ulcers, papules, or tubercles of syphilis.

Treatment.—The treatment of baldness arising from syphilis is that of the disease itself, and when due to the cachexia should be constitutional rather than local. Should this not satisfy the patient, then any of the remedies commended in the foregoing section on treatment of alopecia furfuracea would be applicable here. When due to local lesions of the scalp, to our constitutional treatment we must add local specific treatment. This would vary with the case. To papules and tubercles we may apply mercurial or white precipitate ointment, or a bichloride of mercury lotion one part in five hundred. If ulcerative lesions are present, they may be dressed with iodoform.

Prognosis.—The baldness due to the cachexia is usually temporary. As the patient's health improves, his hair will return. This is true particularly of those who are under middle life. When the baldness is due to the destructive action of the specific lesions it is permanent.

3. *Defluvium Capillorum.*—By this term is meant that sudden and general fall and thinning of the hair which come on during or after some severe illness. It is quite commonly met with after parturition and fevers. It also occurs in the various cachexiæ, and in mercurialism. It rarely produces complete baldness, though it may do so. The fall is usually rapid, the hair sometimes coming out in handfuls. It occurs rather after convalescence from fevers and acute diseases has begun, than during the course of the disease. Seborrhœa may or may not be present.

Etiology.—It is due to a profound disturbance of the nutrition of the hair on account of the illness. That it does not

manifest itself until convalescence from acute diseases is due simply to want of time for the changes in the hair to show themselves, all the processes of growth and fall of the hair taking time to manifest themselves. Unna is probably right in seeking the cause of the loosening and shedding of the hair in the character of its blood supply. He shows that the middle region of the hair follicle is supplied by arterial twigs from the subpapillary circulation, and the papilla of the hair is nourished by little arteries from the deeper arterial circulation of the cutis. The middle follicle region must, therefore, participate in the disturbances of the subpapillary circulation, while the papilla is relatively free from such disturbances. Thus any lessening of the nutritive supply to the papilla, or any increase of the supply to the middle follicle region must cause a preponderance of nutrition in the middle over the lower follicular region. This would cause an increased growth of the prickle cells of the middle follicle region, and an increased pressure upon the hair. Then either the circumference of the hair cylinder would be lessened, or the hair itself would be pressed out of the follicle and raised from the papilla. The latter is what takes place. The "bed-hair" is shoved higher and higher up until it reaches the unproductive part of the follicle, that is just below the mouth of the sebaceous gland, and here it ceases to grow and falls out.

Treatment.—There is no particular form of treatment for this trouble beyond the care of the scalp, as already indicated, and the building up of the patient's strength. Some stimulating wash may be used if demanded. Usually nature takes care of these cases and they make a good recovery.

4. *Alopecia Follicularis.*—By this term is meant baldness due to some disease of the scalp that either destroys the hair follicles or impairs the proper performance of their function. It may be temporary or permanent. It is usually limited in extent and occurs in patches. The various diseases of the scalp that cause baldness are pustular diseases, such as impetigo, sycosis, and dermatitis papillaris capillitii; inflammatory diseases, such as erysipelas; parasitic diseases, such as favus and ringworm; and destructive new growths, such as syphilis and lupus. The appearances presented will vary with the cause, as will also the prognosis. Thus the baldness from impetigo is very limited, confined to but a few follicles; that

from erysipelas is extensive, but usually temporary, the hair growing as a rule, after the disease has run its course; favus produces alsolutely bald patches of cicatrical tissue which are permanent, and may be quite extensive; ringworm causes, as a rule, only partially bald scaly patches with broken-off hair in them; syphilis we have already described; lupus destroys the scalp and the hair, giving rise to a patch of considerable size, involving, it may be, a good part of the scalp.

The etiology, diagnosis, treatment, and prognosis of alopecia follicularis are the same as those of the various diseases of which they are but parts, and for them we must refer the reader to general treatises upon dermatology and syphilis.

Alopecia Areata.

Synonyms.[17]—Area Celsi (v. Baerensprung); Area occidentalis diffluens, seu serpens, seu tyria; Alopecia circumscripta (Fuchs); Porrigo seu tinea decalvans (Bateman); Vitiligo capitis (Cazenave); Ophiasis; Phytoalopecia (Gruby); Teigne pelade (Bazin); Pelade acromatosa, Pelade decalvante, or ofiasica, Pelade (Fr.); Die kreisfleckige Kahlheit (Ger.); Circumscribed baldness (Eng.).

Alopecia areata is marked by the suddenness of its invasion; by the occurrence of more or less numerous perfectly bald circular or oval patches, which usually occur upon the scalp alone, but may occur on any hairy region; by running a chronic course without any subjective symptoms; and by a strong tendency to spontaneous recovery.

Symptoms.—The disease usually begins with great suddenness, the patient finding a bald patch accidentally, or because his attention is called to it by some one. It is not infrequent for the patient to have gone to bed with a good head of hair, and to find on awaking some hair on his pillow and a bald spot on his head or beard. Or the hair may come out in a mass when the brush is used. In most cases there are no premonitory symptoms. In some cases neuralgic pains or localized headaches will antedate the fall of the hair. In most cases there are no subjective symptoms. In some cases the neuralgic pain may continue for a time after the hair has fallen.

The number of bald patches varies. There may be but one patch or there may be a half-dozen or more. Each patch may

attain its full size at once, which is very frequently the case, or it may increase slowly in size, spreading at its periphery. The size of the patches varies from a half-inch diameter to that of a silver dollar, or even to the palm of the hand. The larger patches are usually formed by the coalescence of smaller ones, in which case they will lose their perfectly circular or oval outline. The shape of the patch is circular or oval. Sometimes several patches join at their edges, and thus form an irregular patch. Sometimes a patch becomes serpiginous. The location of the patches varies. They may be scattered over the whole scalp, or they may form only on the temporal and occipital regions. The beard may be affected alone, or together with the scalp. Patches may appear on any hairy portion of the body. Each patch is perfectly bald and smooth, of normal or pale color, or, exceptionally, hyperæmic. There is no sign of scaliness. There may be a few hair roots protruding for about an eighth of an inch above the scalp in the recent bald patches, but these soon fall. The patch looks as if somewhat depressed below the level of the surrounding parts, and is so, on account of the hair and roots having fallen out.

The hair about a newly-formed patch is loosened in the follicles and comes out with slight traction. The sensibility of the skin is decreased. In some cases anæsthesia can be shown by the æsthesiometer. In most all cases the scalp does not react as readily to stimulation as does the normal scalp.

The appearances presented by the disease are so striking that a case once seen will never be forgotten. So much so is this the case that students scarcely ever hesitate in making a diagnosis. The perfectly bald smooth circular patches with a pale or healthy-looking skin stand out in vivid contrast against the surrounding mass of perfectly healthy hair.

An exceptional form of the disease is that in which the whole surface of the body is affected, every hair having fallen from all hairy regions. Some authorities have endeavored to make this form a distinct disease, but there is no doubt that it is but a variety of Alopecia areata. At first only the scalp may be affected, but very soon the whole body is implicated.

The course of the disease is chronic, though it shows a decided tendency to spontaneous recovery. Three months is about the shortest time that we can reasonably expect a return of the hair, though it may grow in sooner. We should

be prepared to wait for two years at least for some cases to recover. After the hair has remained out for a number of months, we will notice in a cross light that a number of lanugo hairs have appeared in the patch that formed first. They are the heralds of the coming hair growth. We must not congratulate ourselves that the trouble is now over, because these lanugo hairs will probably all fall out, to be replaced by hairs of stronger growth. At last fully formed hairs will cover all the patch, but they will be white. After a time the normal color will return to the hair and recovery will be complete. In a few cases the hair will remain in the lanugo stage of development. Relapses may take place, and new patches form after the old ones are well. Hardaway[18] has reported a case that relapsed in the same place every spring for four successive years. I have a case in which recovery took place in November, 1887. A new outbreak of the disease occurred in February, 1888. In another case located in the beard alone, relapses and recoveries have alternated during some two years. While, as has been already noted, there are no subjective symptoms present, many of the patients are of excessively nervous temperaments or exposed to great nervous strain, and not a few of them are out of health in various ways. On the other hand, many of the patients are apparently in good health.

Such is the disease as we understand it in this country. In France varieties are described that we do not recognize. Some of their authors (Gruby, Courrèges) describe cases with scaliness of the scalp, and Cazenave makes a division of vitiligo capitis with discoloration of the hair. As Gruby demonstrated a parasite in the disease, it is probable that he mistook bald patches of ringworm for alopecia areata.

Etiology and Pathology.—The disease is one of the less frequent affections of the hair, and occurs in this country less often than in England. Thus Bulkley's statistics show but forty-six cases in eight thousand, a little more than half of one per cent. The statistics of the American Dermatological Association for the ten years ending in 1887 give but 794 cases in 123,746, or sixty-four hundredths of one per cent. Anderson, of Glasgow, reports 153 cases in 10,000, or about one and a half per cent. Crocker, of London, gives two per cent as the proportion his practice shows.

While all are agreed as to the symptoms of alopecia areata, the greatest disparity of opinion prevails when we enter upon the study of its cause. Whether it is parasitic or non-parasitic is the main question in dispute. A secondary question is whether it is contagious or not. Those who hold to the parasitic origin of the disease believe it to be contagious, and those who believe it to be contagious have faith in its parasitic origin. The greater number of authorities are on the non-parasitic side, and hold that the disease is a neurosis. Let us investigate this interesting question. To do so understandingly it will be necessary for us now to study the pathology of the affection.

If we examine hairs plucked from the margin of an advancing patch they show atrophic changes under the microscope, but there is nothing distinctive about such changes, as similar alterations are found in the hair that falls in all forms of alopecia excepting that from parasitic diseases. We find the hairs terminating in pear or club shaped extremities, with, at times, ampullary swellings near the root composed of a concentration of granular pigment matter. The root sheath, or portions of it, may or may not be attached to the root, and sometimes sebaceous matter may adhere to the shaft, which may appear as bright refracting granules and be removable with difficulty even by ether. Opportunities for post-mortem examination of sections of the scalp affected with alopecia areata do not often occur. Duckworth [19] has reported such a case. He found, "1. A distinct atrophy of the hair follicles and the sebaceous glands in connection with them. 2. Infiltration of the hair follicles, specially their outer root sheath, with a new round-cell growth. This growth appeared to be peri-vascular, and tracts of it were found in the middle layer of the corium leading up to the papillary layer. 3. The hair follicles in the affected area were mostly quite atrophied, their nourishment having been cut off by the new growth. In some instances remains of the papillæ were seen, but the capillary loops were infiltrated with the cell growth. In other instances the follicles appeared to be making efforts at repair by throwing out numerous digitations. 4. The vitreous membrane of the follicles was in some cases hypertrophied. 5. The sweat glands were practically unaffected, though parts of their ducts were implicated in the new growth. 6. No parasitic elements

were found." Other observers have made similar examinations with negative results. Numerous attempts have been made to show the parasitic origin of the disease, and a number of reputable observers have described micro-organisms in connection with it. Gruby [20] in 1843 was the first who did so. He named his parasite "Microsporon Audouini," and described it as arranged about the hair so as to form a sheath or tube, and as consisting of trunks and branches of cryptogamia which began to develop on the surface of the hair at about 1 to 2 mm. below the epidermis. This so-called parasite is, according to Duhring, only an accumulation of sebaceous matter, broken up epidermic scales, and débris about the roots of the hair, the same as has already been mentioned above. Bazin [21] followed in 1862 with his "Microsporon decalvans." T. Fox [22] in 1874 described a fungus composed of very delicate, waxy, mycelial threads. Malassez [23] in the same year declared that he had found the cause of the disease in the form of spores, spherical or ovoid highly refractive bodies, some double contoured and some not, seated in the epidermic scales of the superficial layers of the epidermis, and occasionally upon the hair. Eichhorst [24] in 1879 found spores once in nine cases, which were located between the hair and the root sheath, were round, of yellowish-brown color, of various sizes up to that of a red blood-corpuscle, and with a bright double contour. Thin [25] in 1881 described yet another fungus in this disease as "minute round or elongated rounded bodies in the hairs, arranged in pairs in the long axis of the hair," and named it "Bacterium decalvans." Von Sehlen [26] in 1883 found micrococci in the outer part of the hair follicle just above the mouth of the sebaceous glands in most cases, though in a few instances they were as far down as the papilla. They occurred singly and in colonies, were cultivatable, and inoculations were followed by loss of hair that resembled very closely that which occurs in alopecia areata, but with a good deal more scaling.

The most exhaustive study of alopecia areata of recent date has been made by Robinson [27] who read a paper on the subject before the Section for Dermatology and Syphilis of the International Medical Congress held in Washington in 1887. He declares himself to be of the number of those who believe in the parasitic origin of the disease. In seven cases of alopecia areata he found evidences of inflammation, and a not very

extensive round-cell infiltration, which was confined principally to the perivascular region, the connective-tissue cells taking part in it to a small extent. That the inflammation was most pronounced in the perifollicular region was due to the gland tissue being better supplied with blood than the corium. In recent cases there occurred coagulation of lymph in many lymphatics and a consequent stoppage of the lymph flow. There was also coagulated fibrin in a few of the large and small arteries, and, in old cases, a thickening of the walls of the blood-vessels. In recent cases only the hair follicles were affected. They were either without hair, or contained a lanugo hair, or one just about to fall. The hair roots, where hair was still present, showed atrophic changes. In advanced cases the sebaceous glands were degenerated or had entirely disappeared. In the worst cases there was complete atrophy of the hair follicles and of the subcutaneous fatty tissue. Besides these changes cocci were found in recent cases in the lymph-spaces of the corium and in the walls of a few of the blood-vessels. They were small, round, dark colored bodies of almost uniform size, and grouped in zoöglœa masses. Neither acids nor alkalies acted upon them. Most of them were in the middle part of the corium, a few were in the papillæ, and often they were found deep down in the lower part of the corium. Their diameter was about 8μ and their size was that of the staphylococcus pyogenes aureus. Diplococci were frequent. They decreased in amount with the duration of the disease. These micrococci are regarded as the cause of the inflammation that produces the plugging up of the blood-vessels and the symptoms of the disease.

We have now learned what the pathological anatomy of the disease has been declared to be by competent observers; and what the very varying microscopical appearances are upon which has been founded the parasitic theory of the disease. Let us now turn our attention to the experiments and observations of those who believe that alopecia areata is of neurotic origin. To Max Joseph [28] is due the credit of instituting a series of experiments to determine the neurotic origin of the disease. His experiments and those of others following his methods show that by extirpating the second cervical ganglion in cats it is possible to produce patches of baldness bearing strong resemblance to what obtains in alopecia areata.

The patches slowly increased in size to that of a silver quarter of a dollar. Microscopical sections of the affected areas showed atrophy of the papillæ. There was no alteration in the sweat and sebaceous glands, and no inflammatory symptoms. He believes that these experiments demonstrated the existence of vaso-motor nerves, and that the alopecia was the result of their injury. Samuel [29] repeated these experiments, but, though he produced the same areas of baldness, he found that there was always infiltration about the wound and the formation of abscess. As soon as the infiltration subsided the hair began to grow again. Mibelli [30] has likewise repeated the experiments, and produced great disparity of results. In some cases the hair fall followed both in the regions of distribution of the nerves and in parts more or less distant. In some cases the hair fell from regions outside of those operated upon. The hair fall followed in from nine to forty-seven days after the operation. In most cases there was no change in the skin. In one case there was a superficial abrasion; in another there were crusts in the centre of the bald spot; and in another there was true eczema. He believes that the alopecia was not due to cutting the trophic nerve, as in that case the hair would not grow again. His theory is that excision of the second cervical ganglion may produce a disturbance of the nerve centres and thus cause reflexly a change in the blood supply to the skin, and loss of hair.

Loss of hair confined to definite areas has not infrequently resulted from accident, the areas resembling those of alopecia areata, excepting that they are more irregular in shape. Among those reported the following will serve for illustration. Uchermann [31] reported a case arising from a blow on the head with a stone. Michelson [32] met with a case following a fall on the head. Tyson [33] has reported three cases following nervous shock. A case has been observed of hair fall following a cut on the scalp by a barber's shears. One of the most important of these cases is reported by Pontoppidan [34] which followed an injury to the external carotid artery for which a tampon was applied. Two days afterward paralysis of the left sympathetic showed itself, and three weeks afterward when the bandages were removed a number of symmetrical bald spots were found on the occiput, which gradually increased in size so that at last the occipital region was nearly bald.

The next question that concerns us is whether alopecia areata is or is not contagious. While nearly all if not all those who believe that the disease is due to nervous influences deny that it is contagious, all those who believe in its microbian origin assert with equal positiveness that it is contagious. It must be granted that there are a goodly number of recorded observations of alopecia areata occurring in an epidemic manner, and that these give a sufficient basis upon which to erect a theory of contagion. Thus Hillier[35] in 1864 reported several cases occurring epidemically. Thibierge[36] saw the disease break out in a barrack and attack a number of soldiers. Subsequently a number of cases occurred in the town in which the barracks were located. Fournier[37] reports an epidemic of the disease in a regiment quartered in Paris. Eichhoff[38] has met with thirty-six cases occurring during two years in Elberfeld, of these ten were customers of the same barber. There was an epidemic of ringworm at the same time. Other observers have reported similar outbreaks.

As other alleged causes of the disease the following may be cited: Disturbances of general nutrition, as from recent constitutional syphilis; menstrual disorders; arsenic; parturition and pregnancy.

And now, what conclusion shall we draw from this mass of conflicting evidence? And first let us ask, Is the microbian theory proved? At present it seems as if we must answer, No. We see that there have been a number of parasites described by different more or less skilled observers, and that while each one believes that he is right, he has no seconder. This is different from what obtains in other parasitic affections, and justifies us in doubting whether there is a microbe at the bottom of the trouble. Von Schlen's micrococci have been declared by Michelson, Bender, and Bordoni-Uffreduzzi as very commonly found in the normal condition of the scalp. Robinson's micro-organisms are declared by Leloir[39] to be either the mast cells of Ehrlich, or granules of precipitated coloring matter.

Secondly. Is the disease contagious? It is somewhat difficult to answer this question. The diagnostic ability of some of those who have reported epidemics is so well established that it may be somewhat presumptuous to doubt their diagnosis. Still it must be remembered that there is such

a thing as bald trichophytosis capitis, and the possibility of confusing this disease with alopecia areata must ever be held in mind. Certainly contagion is very rare. Robinson would explain this by the location of the micrococci, which lie in the corium, and not in the epidermis. It is best at present to answer this question, by saying that there is a possibility of the disease being contagious.

Thirdly. Are we justified in regarding alopecia areata as a neurosis? We have learned already that in some cases symptoms of nerve disturbance, such as headache and neuralgia, precede the hair fall; that other cases follow closely upon injury to the head and nerve shock; while in still other cases, such as those following parturition, arsenical poisoning, menstrual disorders, anxiety, nervous strain, and disturbances of general nutrition, it is fair to suppose a lowering of nerve force; and, finally, that reaction to stimulation is much lowered in the patches. Moreover the sudden fall of the hair, and the occasional implication of all the hair of the body are more readily explained by the theory of nerve disturbance than by any other. In one case, at least, the cutaneous nerves presented all the signs of parenchymatous degeneration.[40] Whether the disease is or is not a true tropho-neurosis cannot be determined at present. In the uncertainty that still obscures our judgment of the etiology of alopecia areata, perhaps we can do no better than to accept, for the time, Leloir's[41] conclusions: "Cases of alopecia areata may be divided into three classes, viz.: 1. Tropho-neurotic, where there is no trace of contagion, and where nervous phenomena are sufficiently characteristic and closely related to the appearance of the hair fall to constitute a probable cause. These would constitute about one-third of the cases. 2. Cases in which neither nervous phenomena nor contagion can be established as a cause. These form another third of the cases. 3. Contagious variety, in which contagion could be established, but no trace of a parasite could be found."

The disease attacks both sexes with nearly equal frequency, though some statistics place the preponderance on the side of the male sex. Children are quite frequently affected. In Crocker's practice 37 out of 83 cases occurred under the twelfth year, and 54 under the twentieth year. But his experience is very largely among children. Bulkley's tables show it

to be most frequent between the ages of twenty and forty. In statistics from my own practice compiled some three years ago, the disease occurred 29 times in 3,900 consecutive dispensary cases. Seventeen of these were males, and 12 females; 10 were under twenty, 18 were between twenty and forty, and one was over forty years of age. The youngest was five years old. Crocker gives the range of ages as from two to sixty years, his youngest being three years old, and his oldest being fifty. Bulkley's youngest case was six years old, and his oldest fifty-four. It is rather more frequent among the poor than among the rich and well-to-do.

Diagnosis.—Alopecia areata presents such marked and peculiar symptoms that once seen it is not readily forgotten. Ringworm of the scalp is more liable to be taken for it than any other form of disease. It is necessary also to differentiate it from favus, and from other forms of alopecia.

DIFFERENTIAL DIAGNOSIS FROM TRICHOPHYTOSIS CAPITIS.[42]

Alopecia areata.	*Trichophytosis capitis.*
1. Occurs suddenly without antecedent lesion, and the patches often attain their full size at once.	1. Begins usually at one point by a small erythematous papule or patch, and spreads from it more or less slowly.
2. Patch usually perfectly circular and does not contain gnawed-off hairs, nor scales, nor crusts, but is perfectly smooth and shiny.	2. Patch more or less circular, with broken and gnawed-off hairs in it, and floor covered with thick, grayish crusts or abundant scales.
3. Hairs about patch unaltered, though at times they may be easily extracted.	3. Hairs in and about patch are brittle, break easily when pulled on, and bend at an angle.
4. Occurs only on hairy parts of the body.	4. Occurs both on hairy and non-hairy parts of the body, and patch will sometimes spread from non-hairy to hairy parts, or *vice versa.*
5. No parasite found, or at least not readily detected.	5. Fungus found abundantly in hair and scales.

The diagnosis may be more difficult when the ringworm patch has become perfectly bald. But even then the fungus will be found in the neighboring hair, and there will probably be characteristic patches or stumps elsewhere on the scalp.

The bald spots of favus are irregular in shape. If the disease is recent, the pathognomonic cupped crusts or asbestos-like masses of scales and débris, and the peculiar odor of favus will aid us in the diagnosis. If the case is of long standing, there will be bald patches of cicatricial tissue present, entirely unlike the smooth, apparently unchanged scalp of alopecia areata.

The whole course of alopecia senilis and presenilis is unlike that of alopecia areata, and it seems hardly possible to mistake one for the other. Syphilitic alopecia does resemble alopecia areata. But in it the baldness is rather a general thinning than an areate one, and if bald areas do form they will be irregular in shape. The history of the case will decide in doubtful cases. If the baldness be due to the absorption or ulceration of syphilides, the history of the same, and the cicatrices left will leave no doubt as to the diagnosis.

Treatment.—Whatever theory of causation is held, one thing all will grant, and that is that in many cases the general health of the individual will need attention. Most cases require a stimulating or tonic treatment, such as iron, quinine, arsenic, strychnia, cod-liver oil, or hypophosphites. Children should be taken out of school, and an endeavor made to induce adults to lay aside their anxieties or lighten their burdens. This is far more difficult of attainment than any part of our treatment, but unless the nerve strain that is pulling the patient down be lessened it will be extremely difficult to produce a speedy cure.

In a disease that shows a marked tendency toward recovery it is difficult to determine just how much our remedies effect. As the disease has no regular course, we perhaps ascribe too much virtue to our treatment in some cases. The probabilities are that we do shorten the course of the disease by treatment. What we wish to effect in treatment is stimulation. Those who hold the parasitic theory say that we must use parasiticides. As the parasiticides that prove effectual in this disease are all stimulants, they fulfil just the office that we want them to.

Tincture of cantharides; cantharidal collodion; the stronger water of ammonia; sulphur; the bichloride, yellow sulphate, and oleate of mercury; croton oil; chrysarobin; jaborandi or pilocarpine; galvanism; each of these has its advocates. As the diseased scalp will tolerate a good deal of stimulation, we must use our remedy of sufficient strength to produce redness of the scalp.

Cantharides is much used in the form of the tincture, one or more drachms to the ounce of excipient. The catharidal collodion is used in the blistering plan of treatment much in vogue in France. Vidal's[48] method may be taken as illustrative of this plan. It is as follows: If the subject is a child, the whole head is to be shaved. If the patient is older, the scalp is to be shaved for half an inch around the bald spot. A blister not larger than a twenty-five cent piece is to be applied to each bald area in the morning, and removed when the epidermis begins to rise. If a large bleb forms it should be opened. The blisters should be powdered with starch and covered with linen. If there are numerous bald spots, apply the blisters to them successively. If the hair does not grow after thorough blistering, repeat the operation as soon as the effects of the first application have disappeared. If blisters are not well borne, use sinapisms. When the hair begins to grow, shave, and rub in, every morning and evening, a lotion of

℞ Liquor. ammon., ... 4. say ʒ i.
Spt. vini rect., ... 16. " ʒ iv.
Decoct. foliæ juglandis, . . . 120. " ℥ iv.
M.

If the disease affects the face, shave every day and apply tincture of cantharides either pure or with one-fifth to one-sixth tincture of rosemary. Warren Tay, of London, is particularly fond of Burt's Blistering Fluid, a patented preparation probably containing cantharides. He applies it with a stiff brush to the patches once every two or three weeks.

The stronger water of ammonia used pure will render excellent service in some cases, while in others it will have no effect. It should be applied by means of a swab, the patient and attendant being warned to guard the eyes from the fumes as well as the fluid. It is remarkable how little reaction will follow this powerful irritant.

Mercurial preparations are highly esteemed by those who

believe in the parasitic origin of the disease. Lassar saw good results in cases treated with a solution of corrosive sublimate followed by disinfecting oils, such as salicylated and carbolized oils. In a case of my own the application of a solution of corrosive sublimate, three grains to two ounces, was followed by the growth of lanugo hairs in fourteen days, and of good strong hairs in three months. Crocker uses a solution of the bichloride of mercury, two to four grains to the ounce of oleum pini sylvestris, with or without the extract of capsicum a half drachm or more. Courrèges'[44] plan of treatment is to wash the head twice a day with a lotion of

℞ Chloride of ammonia,
Bichloride of mercury, . . . āā gr. i.
Water, ... ℥ i.
M.

or to use an ointment of

℞ Yellow sulphate of mercury, . . gr. xv.
Lard, ... ℥ i.
M.

The oleate of mercury in the strength of two to ten per cent will sometimes promptly cure, and sometimes it will have no result.

Croton oil is used for blistering, and is but another form of treatment by this method. Robinson, in his already oft-quoted and excellent brochure, says the croton-oil treatment has given him more satisfactory results than any other. To begin with, equal parts of croton oil and olive or any other oil, should be used, and the proportion of the croton oil increased or diminished according to the intensity of the inflammation produced. The oil should be applied both to the bald places and the neighboring parts. We should aim to produce a dermatitis of moderate intensity with exudation and infiltration of the tissue, and continue it for weeks. Its favorable result is due to the emigration of white blood-corpuscles into the lymphatics, which destroy the organisms. The danger of producing destruction of the hair follicle by too strong applications of croton oil must not be forgotten. Chrysarobin in the strength of fifteen or twenty grains to the ounce is recommended strongly by Robinson. Crocker uses it as strong as one drachm to the ounce. The usual cautions against getting it into the eyes should be given.

Jaborandi has seemed to prove curative in some cases in my hands, but was of absolutely no value in others. A pomade was used which was made by boiling down the fluid extract to half its volume and adding one part of this to four of lard. Hypodermics of pilocarpine are commended by one or two authorities.

Galvanism may be tried as well as static electricity.

Sulphur ointment has proved serviceable in the hands of Thin, and he has published [45] a series of cases showing its efficacy. As special treatment the following may prove useful: Cottle has the affected area painted with acetic acid until the scalp whitens, and then sponged off with cold water, once every three or four days. In the intervals an ointment of three drachms of balsam of Peru to an ounce of benzoated lard is to be applied.

Guibout recommends shaving, frictions with camphorated alcohol, and frequent bathing with equal parts of camphor and sulphurous ether.

Hardy epilates the hairs from about the patch, and for a few days applies every morning and evening a solution of corrosive sublimate, one in five hundred. Then an ointment of

℞ Yellow sulphate of mercury, . . . gr. xxx.
Camphor, ... gr. xv.
Lard, ... ʒi.
M.

is to be used. After a time this last is to be used in the evening and spirits of camphor in the morning, or a ten-per-cent solution of tincture of cantharides.

Shoemaker recommends occasional poulticing and the use of the oleates of mercury.

When the young hair begins to grow it should be shaved off once every week or so, and some stimulant, such as tincture of cantharides used.

Prognosis.—The chances are all in favor of the hair being restored in recent cases and in young subjects. In persons on toward middle life the prognosis should be guarded, as the disease is prone to leave permanent baldness. If the case has lasted a number of years, and there is no sign of young hair, the prognosis is grave; we cannot expect much from our treatment.

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THE

SPHERE, RIGHTS, AND OBLIGATIONS

OF

MEDICAL EXPERTS.

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NOT much is known regarding the application of medical knowledge to the end of jurisprudence in ancient times. The earlier Roman law-courts had a short and easy way of settling doubtful medico-legal points by referring them to the "authority of the learned Hippocrates." But when the study of jurisprudence underwent its wonderful development under the imperial sway of Justinian and his successors, serious attention was attracted to medical jurisprudence, and rules relating to its practical application were embodied in those famous compounds of state and judiciary law, the Pandects. Still, the actual beginning of the system, as we now enjoy it, dates from so late as the commencement of the sixteenth century, though even then the experiment was not always attended by happy results, for, naturally enough, medical men shared in many of the ignorant beliefs of the time, and lent the force of their opinions to sustain them. But, notwithstanding this drawback, it soon gave promise of such good fruit that it was deemed necessary to frame a body of rules for the employment of medical witnesses, and for their guidance in the new duties assigned them. These rules are contained in the celebrated "Constitutio Criminalis Carolina," decreed by Charles V., Emperor of Germany, at the Diet of Ratisbon, in 1352. It is therein ordained that medical practitioners shall be called to investigate all cases of death "by wounds, poisons, hanging, drowning, or the like; as well as cases of concealed pregnancy, procured abortion, child-murder," etc.[2] The numerous

works on medical jurisprudence which succeeded the publication of this code amply attest the interest it awakened among the medical men of the day. About the first of these was a treatise by a German doctor, Johannes Bohn, on the subject of mortal wounds, entitled "De Renunciatione Vulnerum," published in 1689. The same author produced in 1704 a more comprehensive work, giving copious rules for the guidance of medical evidence in courts of law; and in Valentine's Pandects, the physicians of the day had, according to good authority, "a compendious retrospect of the opinions of preceding writers on juridical medicine."[3]

At first the right to testify in courts of law was restricted to surgeons. Two of these were appointed in every city and town to examine "all wounded or murdered persons," and to report the facts to the proper tribunal. Such, at least, was the early stage of this novelty in Germany. The French adopted and improved upon the German practice. After the publication of the Caroline Code, Francis I. decreed that both "physicians and surgeons should be legally required" to act in a medico-legal capacity. Subsequently, Henry IV. conferred on his court-physicians the privilege of nominating surgeons in every town "to the exclusive right of exercising this important duty." Finally, Louis XIV. decreed that physicians must always be present with surgeons at the examination of dead bodies.[4] A pleasing example of the authority of medical opinion with courts of inquiry, even in those days, is narrated by Pigray in his "Chirurgerie" (liv. 7, chap. 10, p. 445). It appears that seven men and seven women were sentenced to death for sorcery, and that M. Pigray, with three professional associates, was appointed to visit the condemned in company with the court counsellors, to investigate the truth of the charges contained in the written deposition made against them. The result of the inquiry was a recommendation to the court to remove the sentence of death and to place the fourteen prisoners, whom they discovered to be lunatics, under medical treatment, and we are told the court was wise enough to follow this advice. The progress of enlightenment was slower in England, for we read that, more than a quarter of a century after the occurrence above mentioned, Sir Thomas Browne, author of the fascinating book "Religio Medici," bore "testimony to the reality of diabolical illusions, occasion-

ing by his evidence the conviction and condemnation of two unfortunate persons, who were tried at Bury St. Edmunds before the Lord Chief-Justice Baron Sir Matthew Hale, on the capital charge of bewitching the children of a Mr. Pacey, and causing them to have fits."[5] But this was in the reign of James I., whose obsequious Parliament enacted a law against witches, in the preparation of which men even such as Coke and Bacon took an active part. It was not until the witch craze had spent itself in the execution of some forty thousand men, women, and children, that this terrible persecution was finally stopped by the efforts of Chief-Justice Holt. Among the last of its victims to suffer death in England were two women, executed on the grave charge of having, the devil willing, raised a hurricane by making a lather of soap and pulling off their stockings. But I must ask pardon for this digression.

Undoubtedly, our American physicians are among the most industrious laborers in the field of medico-legal research. So early in the history of the republic as 1810 Dr. Rush drew attention to the subject in an introductory lecture delivered before the University of Pennsylvania, dwelling on the value of medical testimony as an aid in the vindication of oppressed innocence and the punishment of crime. Since then the whole field of medical jurisprudence has been traversed in numerous American works of recognized ability and authority. I need, only mention those of Beck, of Wharton and Stillé, and two valuable productions on medical evidence to which I am much indebted in the preparation of this paper, namely, Dr. Elwell's "Malpractice and Medical Evidence," of which the third edition, revised and enlarged, is recently published, and the excellent treatise on the "Jurisprudence of Medicine," by Prof. Ordronaux.

The word expert means, etymologically, "taught by use, practice, or experience." It therefore denotes one who has a practical knowledge of some science or art. Now, in the case of the medical expert this practical knowledge is only of sterling value to the cause of justice when reared on a solid basis of scientific training. This fact our law-courts do not seem sufficiently to recognize, and it is precisely because they do not recognize it that the question "What constitutes a medical expert?" receives even at this day conflicting answers.

Thus, while in some cases (as in Page *vs.* Parker, 40 N. H., 47) it was ruled that, in questions of skill or science, mere opportunity for observation was not enough, it being necessary that the witness should have superior skill and scientific knowledge, and also a mastery of the subject; in others (*e.g.*, in N. Orleans & Co. *vs.* Allbritton, 38 Miss., 242) it has been held that practising physicians without medical diploma or license from an examining board stand on an equal footing in this respect with the most thoroughly-educated medical men. And in the Livingston case it was the judicial decision "that any practising physician is competent to express an opinion as an expert on a medical question."[6]

A medical expert, properly so-called, is one specially qualified to give opinions on facts having a medical nature and bearing. Of course, this definition will exclude all who, though recognized as physicians by the amended statute, are not legitimate members of the profession. Moreover, it will discriminate between members of the profession itself, and with propriety, I think, for, apart from the fact that some physicians are, by reason of certain advantages of training and observation, more entitled to the position of experts than others, there is no doubt that the interests of justice and the reputation of our cloth require some classification of medical witnesses more in accordance with facts and experience. Presuming this to be true, I might classify them:

A. As physicians and surgeons. This would answer, though imperfectly, in countries where medical and surgical practice are conducted separately, but where such is not the custom, it is open to the serious objection of not being in accordance with fact.

B. As medical witnesses and medical-expert witnesses. This is not only the most natural but also the most widely applicable division, being based on a real difference in the character of medical testimony; and, although not generally recognized in our courts of law, it certainly, if unconsciously, influences the weight which judge and jury attach to separate medical testimonies. Let me be permitted to show the nature of this important distinction. Medical witnesses testify to familiar medical facts, and deliver opinions based on that knowledge of the general principles of medicine which all medical men should have. The value of their testimony will

therefore depend on the range of their general medical information and experience, and not necessarily on a minute acquaintance with some special medical branch. On the other hand, medical expert witnesses testify to special medical facts, and deliver opinions on a more or less minute and exhaustive study and experience of some particular medical subject to which they have devoted special care and attention. As an illustration of my meaning to those to whom it is not already sufficiently obvious, suppose an investigation into an alleged murder by strychnia, and medical men summoned to give testimony. He who has a knowledge of the effects of strychnia and of its obvious properties will testify to these. He will state that it is white, intensely bitter, a valuable medicine in proper doses, a powerful poison in overdoses. And he will tell how much an overdose is, how it causes death, and what diseased appearance it leaves on the body. But if he were required to extract strychnia from this body, to prove by chemical tests this substance to be nothing but strychnia, and to explain the comparative merits of these tests, he might decline by acknowledging his special inability. The court would have to seek the opinion of an expert in toxicology, who in turn would testify with authority on this branch from having a special knowledge of it. The former of these would be a medical witness, the latter a medical-expert witness.

There is no doubt, I believe, as to the reality of this distinction, nor as to the importance of its full recognition in courts of law. One of the reasons of the dissatisfaction expressed, now and then, in regard to medical testimony, is the unreasonable anticipation of its performance, leading to the common injustice of expecting an exact and minute knowledge on all medical topics from all medical witnesses. Next to slander, unreasonable expectation is the greatest foe to character. How prevalent is the false notion that physicians have an intuitive knowledge of their profession—like poets are born, not made—and that "he is no doctor," as it is said, who can't give a solution of any medical question that may be sprung upon him! Nor will this habit of thought excite surprise if we remember how it is kept alive by a certain class of medical practitioners who feign a mysterious knowledge of the healing art. These are the quacks of whom Dr. Parr said that "they endeavor to obtain confidence by pompous pretences, mean

insinuations, and indirect promises." I would press this classification on the attention of legal men in the hope that it may have some weight in influencing the expectations they may in future form of medical witnesses.

Sometimes, as the following example will show, exceptional circumstances have rendered this classification impracticable. In the State of Iowa one Hinkle was tried for poisoning his wife with strychnia (6 Iowa R., 380, quoted from Elwell's Malpractice, etc.). Two physicians stated in evidence that they had never tested for poisons, though they understood the principles of chemistry, and had seen tests applied by chemists. An exception taken to the admissibility of their evidence was overruled on the ground that "to say that none shall be permitted to give their opinions, except those who have given their lives to chemical experiments, or those of the highest professional skill, would, in this country at least, render it impossible in most cases to find the requisite skill and ability." In reflecting on this decision it is but fair to remember that it was influenced by necessity. Still, in a trial involving so much of last consequence to the accused, a successful effort might have been made to procure elsewhere the services of a medical expert. Even the "highest professional skill" is compatible with comparative ignorance of some special medical subject, and I cannot but think it hazardous to admit the testimony of such witnesses as conclusive on a question of chemistry and toxicology.

Experts are called to explain to a jury the meaning of certain facts which might not otherwise be understood. Most trials involve some such facts, and are inconclusive without assistance from expert testimony.

The expert testimony of medical men is the most important of all, for it requires a most minute, varied, and extended knowledge; it frequently relates to subjects of an intricate and recondite character, and it is applied to the settlement of questions affecting the three personal interests which men most love, namely, life, reputation, and property.

Two examples will illustrate its great value. The first is an instance of a crime discovered, and of the criminals punished by the instrumentality of medical evidence, after all ordinary means had completely failed.

In the year 1821 a woman disappeared mysteriously from

the city of Paris. A suspicion that she was murdered led to the arrest of several suspected persons, who, however, were soon liberated, owing to want of proof of their guilt. After eleven years the remains of an unknown corpse were exhumed in one of the city gardens. They were examined by Orfila, Chevallier, and other famous experts, with the result of identifying them with the published description of the murdered woman, and the rearrest and conviction of the previously discharged criminals.

The second illustrates how an innocent man was, perhaps, saved from an ignominious death, and certainly freed from a crushing imputation, by the intervention of the same species of testimony.

Thomas Bowman was accused of murdering an illegitimate child by piercing its head with an awl. The skull was produced in the coroner's court, the hole was plainly visible by all the jury. There was no doubt about the case, and the accused was held to stand his trial for wilful murder. The grand jury sitting in Exeter, England, examined the facts, and were about to bring in a true bill, when Mr. Seldon, a noted surgeon of the neighborhood, heard what was going on. Suspecting some great mistake, he appeared before the jury and asked to see the skull. Perceiving at a glance that the hole was only a natural opening for the transit of a vein, he lost no time in so demonstrating it to the satisfaction of the jury, who, thereupon, procured the honorable discharge of the accused.

The "Quarterly Journal of Foreign Medicine and Surgery," alluding to the importance of medico-legal functions, says: "It is such duties, ably performed, that raise our profession to an exalted rank in the eyes of the world; that cause the vulgar, who are ever ready to exclaim against the inutility of medicine, to marvel at the mysterious power by which an atom of arsenic, mingled amid a mass of confused ingesta, can still be detected. It does more: it impresses on the minds of assassins, who resort to poison, a salutary dread of the great impossibility of escaping discovery."

I.

The sphere of the medical expert is practically coextensive with civil and criminal jurisprudence; but, as it would be im-

possible, within the limits of this paper, to do even scant justice to the subjects thus embraced, I must confine myself to some remarks on his evidence as delivered in a court of law.

Expert testimony begins where ordinary testimony ends. Ordinary witnesses testify to facts of which they are personally cognizant. Their opinions are not usually of any value. But it is otherwise with the expert witness. He does much more than bear testimony of facts, for he delivers opinions not only on facts he has himself observed, but also on such as ordinary witnesses may have declared on oath. His method of procedure is like this: he observes facts, or listens to their recital, weighing and classifying them, and, after their due examination, he then rises to a conception of the general principle of which they are the expression. The stating of this conception in appropriate language constitutes the delivery of an opinion. It follows that his function is judicial as well as testamentary, for he interprets the meaning of certain medical facts just as the judge on the bench interprets the law. His position on the witness-stand is therefore exceptional *quoad* his testimony. Such is the dignified character of his office, but necessarily it has limits, and with these it is his duty to be acquainted. "He should," writes Prof. Ordronaux, "understand at the outset that he is not called to express any opinion on the merits of the case, that he has no proper concern in its issue, and, by whichever party called, he is in no wise the witness, much less the advocate, of that side. . . . His duties are properly limited to gauging the value of certain facts as they appear in evidence—facts whose importance to the issue cannot be determined without his assistance."

The fact, then, that medical testimony chiefly consists of reasoned opinions on statments made in evidence, and the necessity of limiting the expression of opinion within definite bounds, have led to the institution of certain rules by which it is guided. The majority of these rules are scattered throughout an almost endless succession of law reports, and are nearly inaccessible to all but students at law. I will just mention a few, at the same time directing those who wish to see references to some of the latest to the appendix of Dr. Elwell's work on Malpractice and Medical Evidence.

First, a medical witness is not allowed to express an opinion on facts requiring no special knowledge for their comprehen-

sion. Second, he is not allowed to base an opinion on the opinion of another expert.

Third, his opinion should be formed on a personal examination, not on the report of another physician. At first sight it may seem inconsistent that he should be asked an opinion on facts reported by common witnesses, but debarred from giving one if based on the statements of qualified men. But the discrimination is due, no doubt, to the statement of the common witness being rendered under oath.

Fourth, it has been ruled—and this corroborates what I have lately said regarding the importance of putting in practice a certain classification of medical testimony—that a medical witness is not competent to deliver an opinion on insanity unless he has had experience in the treatment of this disease. The wisdom of this decision will be obvious to all who appreciate the many and great difficulties which beset the diagnosis of some forms of insanity.

Fifth, "A medical witness may, when the issue is sanity or insanity, be asked whether such and such appearances, proved by other witnesses, are, in his judgment, symptoms of insanity; but he cannot be asked if the act with which the defendant is charged is an insane act; for this is a fact to be decided by the jury."

Sixth, the expert must be confined in the expression of opinion to the subject on which he has special knowledge.

As time passes and many things remain to be said, I must beg you to be content with this very meagre outline of the sphere of medical testimony, and to permit me to pass immediately to the second division of my subject—the rights of the medical expert.

II.

First of these in order is his right to compensation for his time, labor, and opinion. This is generally conceded by courts of law, on the common-sense ground, I suppose, that as his time, labor, and opinion are his capital, no one has a right to use them without returning interest. The opposite view implies communism to that extent. But, though conceded by the courts, there is popular prejudice against it, and it is commonly objected to medical men that they are actuated by mercenary motives in requiring compensation for their testi-

mony. Adopting the prevalent fallacy, *post hoc ergo propter hoc*, they who make this charge have inferred, from the fact that medical men do receive money for their testimony, the opinion that therefore they sell their testimony for money. The charge would be a very serious one if true. But, in my opinion, it could not be wider of the truth. I don't believe money is the prize which medical men seek in ascending the witness-stand. Nor, to take lower ground, do I think the ordinary compensation sufficient of itself to tempt any wise member of the profession into undergoing the slow torture of a trial and "the law's delays." The desire of fame may indeed influence some, though, I think, not many, and these perhaps only once in a lifetime, or until they cease to be novices to the situation. I really believe, despite the cynical sneer which the announcement may cause among "dollar-getters," that the motives actuating medical experts who enter upon this position are love of scientific investigation, sense of moral duty, and zeal for truth and fair play. But, waiving this paltry objection aside, is there any sound reason why medical experts should not be paid for the labor, time, and trouble they take in aiding judical investigations? Let me dismiss the subject by a quotation from a manly letter addressed by Dr. Hammond to the "New York Tribune" of May 24th, 1870. "While," he wrote, "I hold it to be my duty as a good citizen to testify at any sacrifice to facts, my opinions are my own, and I will not give them, unless I please, without a remuneration in some degree commensurate with the time and labor spent in their elaboration." It only remains for me to say that the fee should be stipulated for before the opinion is given or the cross-examination begins, for, once it is allowed to pass into the *res gestas* of the trial without this proviso, the witness ceases to have any right of property over it.

Second. The medical expert has a right to the courtesy of counsel. Sometimes, I fear it must be said, counsel shows him little consideration. A certain degree of hostile criticism is usually to be expected from lawyers in the interests of their clients, but it is too often carried beyond the bounds of moderation. It may insure a lawyer's triumph to belittle the expert in the opinion of the court, or it may onduce to the success of his cause, but there are other and more honorable means for securing these ends short of assailing a physician's

reputation. We may indeed find a reason for the latitude allowed to lawyers in this particular, in the following words from Chief-Justice Earl, of the English bench: "The law trusts the advocate with a privilege in respect to the liberty of speech which is in practice bounded by his own sense of duty;" for "he may have to speak upon subjects concerning the deepest interests of social life, and the innermost feelings of the soul." But that this liberty is limited, if not by the patience of the court, at least by moral considerations, is a truism on which it would be waste of time to dwell. It is a nice point in casuistry to determine how far a lawyer may go before overstepping the limits of his extended and even elastic privileges. But this much is certain, that, even before he reaches the imposed limit which debars him from aspersing the character of a witness, he may trench on dangerous ground, as, for instance, when, in his address to the jury, he so misstates or distorts the medical evidence as to make it appear other than what it is. Examples of such unfairness have fallen within the experience of most medical men who have appeared in the capacity of witnesses. They are far from being excusable on the ground that the lawyer is not bound by the oath of the witness to speak the truth, because his relations to his client neither absolve him from the higher law nor from respect to healthy public opinion. I may further remark that the heat engendered by a closely-contested case may palliate, if it does not excuse, the faults of lawyers now under consideration, but there is no such apology for the conduct of judges who allow scientific testimony to be indecorously handled. They seem prone to forget that the process of "brow-beating," to which medical witnesses have to submit, often defeats the very object of judicial investigations. This view may be supplemented by some remarks on the difficulties natural to the position of the medical witness, which I find so well put in Paris and Fonblanque's "Medical Jurisprudence" that I shall not apologize for giving them in their own words: "A scientific witness fully acquainted with the subject in dispute, and by particular knowledge well qualified to inform the court on the most important points, is too frequently rendered miserable in himself and absolutely ineffective to the ends of justice by the diffidence which a man of real acquirement generally feels when impressed at once by the novelty of his situ-

ation, . . . the importance of the duty which he is about to perform, and consciousness that the truths he is about to utter may be obscured, suppressed, or perverted by technicalities for which he is unprepared with any defence. . . . We do not mean to arraign the present forms of examination in general when we assert that some abuse in practice too frequently places the medical witness in as painful a situation as if he were himself a criminal." I, on the contrary, believe that the "present forms of examination" may very justly be arraigned, and that they are susceptible of improvement. At the same time let me hasten to state my conviction that the number of lawyers who abuse their privilege is few as compared with the many who do not. I have entered my protest against the length to which some go, and all, perhaps, think they have a right to go; but, this much being said in the kindliest spirit to our legal friends (and I wish some lawyer would arise in this assembly and point out the deficiencies in the conduct of medical men viewed from the stand-point of the legal profession), I will now add my belief that medical witnesses are treated, as a rule, with high consideration by counsel, and that, very properly, the more important and influential they are the greater is the deference paid to them. This, I repeat, is very proper, but I must beg them to keep a corner in their hearts—a cynic might say a corner in their pockets, it being a popular error that lawyers have no hearts —for the humbler, though perhaps equally worthy, members of my profession. There is, let me say, a tendency to pay exclusive deference to those whose reputations have impressed us with feelings of respect and reverence. We often pride ourselves on a sort of intimacy with people whose names are spoken with admiration in the public places, though we may have had no personal intercourse with them. We are all, indeed, lawyers as well as others, given to undue reverence for authority. And so it results that exclusive and, I had almost said, obsequious deference is paid to Professors A and B because they happen to be considered the major lights of their profession; so much so, that if a scientific man who has put his light under a bushel, but who also may be just as competent, is induced to confront the opinions of these others, we are tempted to conceive a contempt of his mental calibre and to regard him as one of the too numerous conceited individuals

who "rush in where angels fear to tread." Well, who will affirm that counsel is exempt from this same failing; and does it not explain why medical witnesses who, though able and learned, may not have had their talents trumpeted abroad, meet sometimes so little consideration at their hands? This is a petty grievance to be sure, but it deserves a remedy, and this I think is to be found in more intimate intercourse between the members of the two professions. For, lawyers and physicians cannot long associate together without great mutual benefit, and without discovering among themselves much latent ability requiring only the stimulus of contact to be quickened into life. But intercourse should not be confined to these meetings. The leading members of this association would confer no small boon on both professions by encouraging that social communion among them which is the cement of all good understanding and friendship. The benefits of such an intercourse, full, free, and untrammelled by the forms of our society reunions, would flow out on all sides, increasing the amenities of life, and otherwise contributing to the general benefit.

Third. The medical witness is entitled to have questions put to him in a clear, intelligible form. The unintelligibility of many of these is a subject of surprise and comment among medical men. They complain that they often betray such a want of precision that the medical witness is puzzled how to make sense out of them. The reason seems to me obvious enough. It is almost as difficult to put a sensible and precise question as to frame a guarded answer. Both acts require an intimate knowledge of the subject on which the examination is to be conducted, based on a systematic preliminary training in its elementary principles. It is not reasonable to expect that men, however intellectual and studious, can supply deficiencies in this respect by a few weeks', or even months', cramming for a trial. Indeed, the real wonder is that counsel succeed so well, considering all the disadvantages under which they labor. In pointing out these things to our legal friends I am quite sure we have no intention of assuming airs in their presence. Such pretension would indeed be very absurd, for there are points of culture in which the advantage is conspicuously on the side of the legal profession. I might instance the faculties of argument and expression—of dialectic,

in a word—arts in which medical men are usually deficient, but which are the necessary qualifications of the lawyer. Various remedies might be suggested for this defect of questioning, the most effectual of which I will, however, reserve for a future part of this paper. But for the present I will mention, as a good empirical reform, the employment of medical men to assist in preparing the medical parts of lawyer's briefs.

Fourth. The right to use memoranda, conceded to all witnesses, is particularly necessary to medical men, whose investigations are frequently of a nature too complex to be accurately reproduced without them. It is one of the wonders about the human mental constitution that impressions, fading in the excitement of engrossing occupations, are so quickly resuscitated by artificial aids. One of the most effectual of these is a written document, which, though not received by courts as a substitute for memory, is permitted as an aid to recall the past. It is immaterial whether the memoranda are made by the witness himself or to his dictation, by an assistant, provided they be taken at or soon after the investigation, for with each succeeding day's delay their reliability is more and more weakened. In drawing up memoranda we cannot be too exact in attending to facts and dates. These require to be recorded with scrupulous accuracy. As regards facts they should be conscientiously set down as they appear; and too many precautions cannot be taken against the besetting error of mixing them up with inferences. The golden rule would seem to be to state the facts first and the inferences last; to state the facts fully and the inferences cautiously.

III.

The obligations of medical experts, which I will next consider, are divisible under three chief heads: 1. His obligations to courts of law; 2. To medical science; 3. To his professional brethren. The last of these will form a heading for some general observations on the duties of medical men toward those of their profession who are defendants in suits for malpractice. The three will be considered in the order above stated:

1. *His Obligations to Courts of Law.*—In many cases requiring legal investigation the coroner's court is the first

before which a medical witness is summoned. The laws of this State "make it the duty of coroners to summon a medical witness," to be present at inquests. "And it shall be the duty of every coroner to cause some surgeon or physician to be subpœnaed as a witness upon the taking such inquest," says the statute (vol. iii., p. 1036, "Revised Statutes of New York"). It declares that physicians so summoned shall be liable to the same penalties if they refuse to attend as are provided in other courts, and yet, by an extraordinary omission, it affirms nothing in regard to their compensation. Now, though it may be a little out of place, I must observe that, for consistency's sake alone, their labor should be compensated here as in other courts. The character of the service is precisely the same. That its remuneration should be a recognized thing in one and not in the other court is, to say the least, evidence of a very unsatisfactory state of the law on the subject. A more just and rational provision is made in the British possessions, though by no means an adequate one. But, at all events, it has the merit of greater consistency. There medical witnesses receive from town or county a fee of five dollars for expert testimony given before a coroner's court, and ten dollars if required to make a post-mortem examination. I fear time will not permit me to enter into details regarding the physician's duties at coroners' inquests. I must content myself with referring to Taylor's and Beck's manuals for most that is required to be known on the subject. Suffice it to remark here that he should be very circumspect regarding the opinion he gives at the inquest, both on account of its paramount influence with the coroner's jury, who look to it sometimes for sole direction, and of the severe criticism it must undergo in the higher courts.

The question, whether a medical man can be compelled to appear in court as a skilled witness against his will, comes next in this section. The general opinion is in the affirmative, though, as we shall see, there is not unanimity among the judicial decisions on the subject. I speak of skilled witnesses, because only in reference to such has any doubt existed, all citizens being obliged to give evidence in courts of law as ordinary witnesses. The usual mode of summons is by subpœna, which is a positive command obliging obedience under pain of certain specified penalties. It was indeed held at one time

that this command was binding on ordinary witnesses only; that medical experts being, as it were, extraordinary witnesses, could not or should not be compelled to attend court against their will. This, in fact, was the opinion of Lord Campbell in Betts *vs.* Clifford, Warwick Assizes (quoted in Taylor's "Medical Jurisprudence"). He held that "a scientific witness was not bound to attend upon being served with a subpœna, and he ought not to be subpœnaed. If the witness knew any question of fact he might be compelled to attend, but could not be compelled to give his attendance to speak to matters of opinion." Prof. Ordronaux, in a foot-note to his able work on the "Jurisprudence of Medicine," suggests that Lord Campbell's language could not have been accurately reported, because, "in the first place, it has never been admitted to be within the discretion of any person to disobey the subpœna of a court within whose jurisdiction he may chance to be. . . . In the second place, even if told the purpose of his examination, he can exercise no choice in the matter of his attendance, unless he could show that he was neither a competent or ordinary witness, nor an expert; but, as he can never know this absolutely in advance, it is certainly made his duty to obey the subpœna." Although this is not merely the most likely but the only logical view of the matter, being also what our law-courts would generally assent to, yet I find the old opinion reaffirmed by Mr. Justice Sprague, of the United States District Court. The question was as to the right of said court to compel the attendance of an interpreter who had disobeyed a subpœna. After stating that on a former occasion he had refused "to issue process of arrest in such cases," he proceeded to say: "When a person has knowledge of any fact pertinent to an issue to be tried, he may be compelled to attend as a witness. In this all stand upon equal ground. But to compel a person to attend merely because he is accomplished in a particular science, art, or profession, would subject the individual to be called upon in every case in which any question in his department of knowledge is to be solved."—(In re Kœlker, 1 Sprague Dec., 276, from Appendix to Elwell's "Malpractice and Medical Evidence.") Thus unsettled stands the question. We may say of the controversy upon this question what Curran remarked about an indefinite speech, that "it begins at a point and goes on widening and widening until it

fairly puts the question out altogether." In this as in other circumstances, however, we will find prudence the better part of valor. It will be at least expedient for us to obey the summons, even though issued by so indulgent a judge as Mr. Justice Sprague.

2. *His Obligations to Medical Science.*—The medical expert in a court of law occupies the distinguished and responsible position of representative and exponent of the most advanced ideas and most recent improvements in medical knowledge. It is hence requisite that he be well learned not only in the fundamental branches of medical science, but also in the latest researches and most improved methods of investigation. This proposition is so obvious and reasonable that the bare statement of it should suffice. But something further is requisite to constitute what is, in the broad sense of the term, a good witness, and a fit representative of the medical science of the day. If this knowledge is to be made effectual it must be assisted by two important acquisitions, namely, by powers of observation and by faculties of reasoning correctly on the facts observed. To these must be added an amount of practical experience sufficient to enable him to bring this knowledge to bear on the points under investigation. According to the degree of proficiency in these things will the reputation and usefulness of the medical witness be affected for good or evil, and hence they deserve to be seriously considered.

Medical men—in matters relating to the sick, such quick observers—are, when summoned to act in an unusual capacity, like people generally, liable to overlook valuable facts. This defect, of which we are all more or less conscious, is partly occasioned, I think, by undue concentration of the mental faculties upon purely professional subjects. The mind, absorbed in this one pursuit, is not free to receive new impressions; or it becomes imprisoned in its own conceits, and a narrow, pedantic character is the result. Part of the defect is also due to neglect of discipline and self-culture. But by far the greatest portion is the result, I feel convinced, of the educational system pursued in our medical schools. With the great defects of that system, as a whole, I have not now to do. The remarks which I am about to make relate immediately to that department of it called medical jurisprudence. Let me

say, on the general question, that I am wholly in accord with those medical reformers who urge upon our attention the advantages of giving this system much more of a practical character. I think they are entitled to our gratitude for pointing out its incompetency to fit medical men for the ever-widening circle of duties imposed upon them by the exigencies of modern society. If we were to judge by the system they so earnestly condemn, we would be forced to believe that physicians and surgeons have no other duties apart from writing prescriptions and setting broken bones, for it unaccountably neglects that essential practical instruction which they should have as necessary preparation for the important functions they may be called upon to discharge to the State in presence of an exacting and critical public. As a particular instance of this defect, let me point to the practice of confining tuition in medical jurisprudence to dry theoretical disquisitions, given at the fag-end of a curriculum, and offered as a substitute for that practical instruction which is of far greater value. How nearly fruitless these lectures are the experience of every student who has been schooled in the art of acquiring knowledge under difficulties will tell him. I do not think I exaggerate the defects of this kind of instruction, when I say that, of the numbers of aspiring young men annually turned out by our medical colleges, ninety-five per cent have no practical knowledge of legal medicine; hardly one, if brought face to face with an accidental death or wounding, would know how to apply the meagre theoretical knowledge he has received from his lectures and his text-book; hardly one would make a respectable display of what he does know if asked to perform an autopsy or give a statement to a coroner's jury.

We pride ourselves, and to a certain extent justly, on the superiority of our institutions of learning; but in all that relates to the practical application of knowledge, and particularly medical knowledge, to the service of the State, we are, I really believe, behind what some of us might choose to call "the effete monarchies" of Europe. Let me instance, as an example of what we might profitably imitate, the school of legal medicine attached to the University of Berlin, wherein each student who desires it receives practical instruction in medical jurisprudence, enjoying opportunities of examining the living, of making autopsies, of analyzing poisons, of essay-

ing the right methods of applying various tests, such as those required to ascertain the modes of death of infants—in a word, of putting to practical use the discourses heard in the lecture-room. The Austrian system, if I am correctly informed, is, or was equally good, and the French, though deteriorated within the last fifty years, and now much more defective than need be, is still better than any either England or America can lay claim to. Many stanch supporters of the constitutional freedom and liberal institutions of Britain have deplored her deficiencies in this respect. Dr. Gordon Smith, for example, in the course of his work entitled the "Analysis of Medical Evidence," earnestly insists on the necessity for a law demanding more special qualifications for medical witnesses, accompanying, however, his recommendations with a superfluous note of national glorification. "Though," he writes, "one of the last of his countrymen who would wish to see the customs and institutions of Great Britain shaped according to foreign patterns, we might take a hint from and improve upon their practice." Truly, and we also in America, overlooking this appeal to national vanity, may take a hint from, and, at least, try to "improve upon their practice." That there is ample room for improvement is evident from this one fact, that we are to this day nearly as deficient as the English were three-fourths of a century ago, when even John Hunter had to deplore to his class his want of sufficient medico-legal training, accusing himself of incompetency at the trial of Sir Theodosius Boughton. It is mere folly to expect that, because a youth has gone successfully through the ordinary medical curriculum, he will be fitted to discharge the important duties of a witness in a court of law. For, though his professional learning is essential to him here as elsewhere, yet the demands of the position are so exceptional—have so much to do with applied science and a knowledge of circumstances which do not occur in his routine experience—that a training over and above what is purely medical is necessary to him. I will venture to assert as much of the legal profession, for I think that, had they the advantages of this practical education, we should hear at least fewer complaints from medical men respecting their defective method of examining medical experts. But, to be valuable, the education must be unmistakably practical or experimental. Among those who see and lament the great

defects of our present system of medico-legal tuition, the impression prevails that its proper remedy will be found in the more universal establishment of chairs of medical jurisprudence in our medical colleges. Now, though this proposition is undoubtedly good, though it cannot be questioned that such chairs are of great value and worthy your esteem, I will not allow that they are the sole and sufficient remedy for the evil complained of. I believe nothing will do short of a real, practical school of legal medicine, alive to the medico-legal issues of the day, with its morgue, its laboratory, its appliances, its medical and law libraries, its physicians to teach the fundamental branches of medicine, and its lawyers to expound the elementary principles of jurisprudence. We know how valuable such a course of instruction would be to ourselves; and if, as Sir Edward Coke has said, "Some knowledge of every science and art is not only useful but even necessary" to lawyers, we can estimate the essential service it would be to them. Consider, again the value of such a school of legal medicine in the instruction of public functionaries such as coroners, and in fitting them for the duties of their important office. No reasonable man can doubt the advantages which would accrue to the whole community if all candidates for the coronership were required to have a good grounding in the essential principles of law and medicine. It is a conviction with many whose judgments are entitled to great respect, that coroners should be medical men; and, taking things in the chaotic shape in which we find them, there ought to be no doubt about the truth and propriety of this assertion. Certainly, in the present total absence of instruction for laymen in the important duties of the coroner's office, medical men are the only persons at all competent to fill the position. Under our present system—if system it is worthy of being called—coroners do not understand their duties, and consequently they do not fulfil them. This is no novel complaint, for, though seldom spoken openly or where it can awaken serious thoughts among the masses, it is often repeated from mouth to mouth. Still it has been publicly ventilated. Among others I may mention Dr. Semmes as having called attention to it in a report to the American Medical Association, pointing out the slovenly manner in which inquests are conducted in the United States; charging that they are hastily gone through, incomplete and

valueless, and that the action of juries in loosely inspecting the dead is "scarcely a formal compliance with the law." Dr. Beck also, in his work on medical jurisprudence, declares, "That the duties of this office are imperfectly understood, and often most negligently performed, hardly admits of a doubt. The individuals appointed are frequently unfit for the situation, both from habit and education, while the jury are too commonly desirous of hurrying through the investigation."

It is not to be supposed that the scheme of education here advocated would cure all the evils of our coroners' courts, of which there is so much complaint, for many are no doubt the result of abuses which slowly adhere to all institutions, as barnacles gather round the good ship's bottom; but it would remedy some of the most flagrant of them, and contribute largely toward increasing the efficiency of this branch of our criminal service.

The necessity of this special training being conceded, there are other qualifications necessary to medical experts, concerning which a few words may be spoken. There are two minor distinctions among medical men considered as possible expert witnesses, one based on acquired, the other on innate qualities. One is the full result of the special education we have just been considering; the other comes from the possession of distinctive natural powers. This insures a well-conducted witness, that one who is well informed. It is difficult to define what the innate peculiarities are, but they help to make much of the difference between even well-instructed medical men, when they appear on the witness-stand; for, I may remark in passing, not all even well-versed medical men pass successfully through the forms of an examination in this place. It is one thing to be a sound practitioner, and quite another to be a good expert witness, because the kind of knowledge necessary to make a good witness is special over and above what is required for a good practitioner. The innate or natural peculiarities of which I speak are due to temperament and habit of mental discipline. The temperament of some men is such that, despite accurate information, they are failures on the witness-stand by reason of an unconquerable nervousness the moment they encounter counsel in a cross-examination. Others lack the logical faculty of drawing proper inferences from facts, and again others lose presence of mind altogether.

From all that I have now stated on this important branch of the subject it may be inferred that the following qualities are necessary in a good medical witness, namely, a thorough practical training, the logical faculty, and a well-balanced temperament.

The medical witness thus equipped has various important duties to perform. The questions on which he is called to pronounce "are vast and unlimited in their range, and many of them soundless in their depths." He owes it to the cause of justice above all else to thoroughly inform himself on all the points of the case submitted to him. This means that he should avail himself of all the steps for arriving at the truth. What these steps are will depend on the nature of the inquiry, but it is of great importance to the interests committed to him that, before using them, he should have divested his mind of all prepossessions respecting the merits or complexion of the case submitted to him. This is avowedly difficult, for the following reasons: First, the prevailing practice of the daily journals, who prejudge the merits of cases, and who, wittingly or unwittingly, pervade the public mind with a bias derived from reading their opinions. When a case of unusual interest occurs, the journals take sides, and fight over again, with much effusion of ink, mimic wars of the Guelphs and Ghibellines. Medical men are just as liable to be influenced by what they read in these journals as other people, and it will therefore not be out of place to caution those who are employed as experts to forego the discussion until the trial is over, or they have examined the facts on which their evidence is to be based.

Second, the habit of hasty inference, so common even among well-instructed members of the community. It is a common observation that those who jump to hasty conclusions are blindly obstinate in adhering to them, either from inherent narrowness of mind, or from unwillingness to acknowledge an error of judgment. I need not indicate how much all this is incompatible with the duties of a medical expert. We all feel it to be of the last importance that every medico-legal case should be approached with minds free from prejudgments, that it should be allowed to stamp its own impress upon us, that the facts should be observed and examined in their true light; for these are the crude ore out of which subsequent

thought and study must produce the pure coin of expert opinion fit to pass current in a court of law. In this stage of the inquiry the expert can follow no better guide than the following general rules taught by Descartes in his "Discourse on the Right Method of Conducting the Reason:"

1. "Never to accept anything for true which you do not clearly know to be such; that is to say, carefully avoid precipitancy and prejudice, and comprise nothing more in your judgment than what is presented to your mind so clearly and distinctly as to exclude all ground of doubt.

2. "Divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.

3. "Conduct your thoughts in such order that, by commencing with objects the simplest and easiest to know, you may ascend by little and little, and, as it were, step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which, in their own nature, do not stand in a relation of antecedent and sequence."

Lastly, in every case make enumerations so complete, and reviews so general, that you may be assured that nothing has been omitted.

The delivery of an opinion is the proper function of a medical expert in a court of law. Yet he is not allowed to be judge of the facts on which his opinion is asked. If a sick man were to come into your office and state to you a number of symptoms which he alleged to be facts, but which he at the same time debarred you from verifying, and were to require you to base on them an opinion as to the nature of his disease, your dilemma would be of the same species as that of the medical expert in a court of law, with the chief exception that in court all witnesses are under the obligation of an oath. I think I know what course you would take in the case of the office consultation. You would refuse to base an opinion or prescribe a course of treatment on facts, the truth of which you were not permitted to judge for yourself. Yet this is just what a court of law will not allow the expert to do. He must take facts as they are stated to him. "For him to pronounce an opinion," says Prof. Ordronaux, "either upon the truth of the facts given him for interpretation, or upon the merits of the case, would be to usurp the province of court, advocate, and

witness." And the same authority further states that this rule is not adopted with the intention of diminishing the value of medical evidence, but to prevent experts from usurping a power "which they might be tempted to use for the benefit solely of the party calling them." This last expression in reference to the tendency of expert witnesses—a tendency by no means, however, peculiar to them—to assume a partisan attitude, leads me to the point which I argued in a paper I had the honor to read to this Society a year ago. On that occasion, when treating of expert evidence in criminal trials involving the plea of insanity, I dwelt at some length on the same question, and pointed out that this tendency was in great measure due to the prevailing, and, as I think, defective custom of calling such witnesses. I suggested as a proper remedy that the court alone should call and examine medical experts, a suggestion which I am pleased to find sustained by the weighty authority of Prof. Ordronaux, although I must, at the same time, say he throws doubt on its practicability. "It would be better," he writes, "were it possible, for the court alone to examine experts upon those points on which their professional opinions are needed, rather than to hand them over to counsel, each of whom has an interest in making their testimony aid his own side, and to that extent forcibly impressing upon it a unilateral character" ("Jurisprudence of Medicine," p. 123). It is very proper to say to the medical expert, You must come to the discharge of your duty with a mind nearly if not absolutely free from prejudice; you must allow neither interest, nor pride, nor jealousy, nor party-feeling, to influence you; you must stand on neutral ground, leaning neither to one side nor to the other, and deliver your opinion, whatever it may be, solely on the merits of the facts, wholly irrespective of its consequences. No one will question the propriety of this advice, but few can help knowing how much it sounds like a mockery. Because, should his mind escape the bias to which it is exposed, from causes already stated, before he gets to court, and should he succeed in coming on the witness-stand without prepossessions in favor of one side or other, the fact of his being called to do duty for one party, taken with the efforts of counsel to lead or force him in a desired direction, must unavoidably get him into the very trap he is so loudly warned to avoid. And this very testimony

which we are told must be delivered in the interest of no other cause but truth—how is it handled by the opposing counsel? Does he respect its neutrality? Does he not rather try with all his might of dialectic to bend it to the cause for which he contends, or failing here, does he not beat it down and belittle it in the opinion of the jury? What, now, is the fate of your independent medical expert? Does he fare any better than if he were a partisan? Is he not, like Issachar, crouching down between two burdens? Of two things one is true: either the present mode of examining experts is very faulty, or all the talk about the necessity of lofty dignity and absolute impartiality in expert witnesses is "sound, and nothing else." Now, whatever may be thought of the practice of our courts in this respect, we must all heartily wish that such noble sentiments will always actuate and guide the medical expert. Appreciating, as I have no doubt we do, the contradictory requirements of the situation, we know that it would be a much greater public misfortune should medical witnesses abandon their lofty principles, than that the impartial spirit of medical testimony should be outraged by partisan zeal. And, until a change is made which will give the court the sole right of calling and examining the medical witness, we must e'en bear our lot with what equanimity we can.

In the formation of opinion it is well to be on guard against the vitiating effect of certain fallacies. In the preparation of evidence we are liable to fallacies of inspection, or *a priori* fallacies, by which are meant those consequent on forming an opinion hastily and without seeking sufficient evidence of its truth. I will take as an example of this kind of fallacy a passage from the testimony of a celebrated surgeon of this city delivered at the trial of Walsh *vs.* Sayre. Being called, this gentleman testified that he had examined the child, Margaret Sarah Walsh, more particularly her hip joint, *i.e.*, "the posterior aspect of the hip called the gluteal region." The examination proceeded as follows:

Q. Well, did you examine any discharge of fluid that was coming from the orifice; was your attention attracted by that?

A. Yes, my attention was attracted by a discharge coming from the orifice.

Q. Was your attention attracted to the particular char- r of the discharge?
A. Yes.
Q. Well, what was it, to the best of your recollection?
A. It was a glairy fluid, slightly colored.
Q. I need hardly ask you the question—you are acquainted ı the synovial fluid, the character and appearance of the ›vial fluid?
A. Yes.
In your judgment, did you find any synovial fluid dis- ıg from that orifice?
A. It struck me so that it was.
Q. Did you examine it at all?
A. I examined it with my fingers, and looked at its general acity, color, etc.
Q. Was that the opinion you formed at the time, as well ou remember?
A. Yes.
Q. Did you state that opinion at the time?
A. I think it is very likely I did.—("Alleged Malpractice t of Walsh *vs.* Sayre," p. 134. Shaw & Co., New York, 1870.)

The hasty impression snatched from the two facts—the hole in the gluteal region, and the "glairy fluid, slightly colored," issuing therefrom—was unadvisedly delivered as an opinion, or delivered as an opinion without necessary confirmation by further evidence. This is one of the fallacies of observation named non-observation, or the omission of facts which are material to the inquiry. It partakes also of the nature of mal-observation, which is the confounding of "a perception with a rapid inference, or the mingling up of inferences with facts" (Bain's "Logic," vol. i., p. 37). Great caution should always be exercised in the formation of an opinion. This is a lesson not easy to learn. The sanguine, hasty disposition is naturally liable to overleap the details which to the wary are the necessary steps to a conclusion. Hasty inference and hasty action are by no means infrequent, owing to a hurried, slovenly way of thinking, impatient of the work on which an opinion entitled to consideration must be based.

The proper method of forming an opinion falls under that part of logic called analysis and synthesis. It comprehends

the details to which I have alluded, and some more, of which the habit of abstraction is one of the most useful. By abstraction is meant the separation and separate consideration of the qualities of a body or the terms of a proposition. It is a habit of great value in preventing confusion of thought, and in enabling the mind "to concentrate its powers on the one subject of study at the time" (Bain's "Logic," vol. i., pp. 338, 339). Of equal importance to the witness is the "analyzing function of the syllogism." This is the happy faculty of making explicit in the statement what is implied in the thought (Hamilton's "Logic"), the use of which, in the language of Mr. Mill, is "to make us aware when something that claims to be a single proposition really consists of several, which, not being involved in one another, require to be separated, and to be considered each by itself, before we admit the compound assertion" (Mill's "Logic").

Finally, all who are asked to express a deliberate opinion may profit by calling to mind the very pregnant remark of Plato, that "opinion is at its best but a mean between knowledge and ignorance."

Before quitting this part of the subject, allow me to make a few observations on the differences between legal and medical definitions of diseases and injuries. Necessarily these definitions are dissimilar, owing to the different objects or intentions contemplated by law and medicine respectively; the object or intention of law being to settle the bearing of these states on life, liberty, and property, while that of medicine is to facilitate diagnosis, classification, and treatment. As an example let us take the term wounds. In medical science a wound is "a solution of continuity occasioned by external violence;" in law it means "any lesion of the body whether cuts, bruises, contusions, fractures, dislocations, or burns" (Wharton's "Law Lexicon"). In surgical works wounds are classified as incised, contused, and lacerated. But legal authorities divide them into "slight, dangerous, and mortal;" terms which are obviously here used in their relation to the possible or probable contingencies of deformity or death. Thus a slight wound, in the legal meaning, is one neither dangerous to life nor likely to leave a deformity; a dangerous wound may do either, and a mortal wound is one fatal to life. These distinctions are important to the medical expert, for, in delivering an

opinion on the nature of a wound, he should be prepared to meet the legal as well as the medical requirements of the interrogatory. This is a circumstance which gives undoubted advantage to the cross-examiner, and affords him an opportunity of puzzling the medical witness. In their mode of putting such questions, however, counsel often display a happy unconsciousness of the difficulty and even impossibility of answering them, though they demand a direct and positive answer. It seems to be a prevailing impression with them that the site alone of the wound governs its mortality; that all wounds of the head, or chest, for instance, are mortal. The question is often put thus: "Are wounds of the head mortal? answer me, yes or no." Now, it is evident to the merest tyro in medicine that no such answer can be given, because the mortality of a wound depends on other circumstances than its mere site, namely, on its character, extent, depth, and on its involving vital parts. But, I fancy I hear a disputatious lawyer exclaim, "What! is not the head a vital part? You are surely talking nonsense." Well, here is the answer. The integrity of a man's scalp is not necessary to his life, as my outraged legal friend might discover for himself by trailing the tail of his coat on the Plains. But, to scalp a man is certainly to wound his head; therefore all wounds of the head are not mortal. Some are, others are not; anyway, it is impossible to give the answer demanded by the question just cited.

The same difficulty presents itself in many of the questions put about diseased states. A medical expert is sometimes asked to define insanity. Now, to define a disease is to select some essential character which will be true of it in all its varying phases and circumstances. If insanity presented any such constant condition, a definition could certainly be framed which would stand for the abstract notion of it. The modified states of these characters found in various phases of insanity would stand for definitions of these phases. But a definition of insanity is impossible because it presents no such condition. The truth is, however, that definition and description are often improperly used synonymously. When a medical witness is asked to define insanity, the intention is to have him describe it, and then the proper return question of the medical expert is, What kind of insanity do you wish described? While on this subject I may remark that there is a strange diversity of

opinion among legal men as to the practical value of expert testimony in trials involving the question of insanity. According to some, the courts are chiefly guided by medical experts; according to others, expert evidence, instead of elucidating the subject, only involves it in greater mystery. An English judge is reported to have expressed himself as follows on the subject: "His experience taught him that there were very few cases of insanity in which any good came from the examination of medical men. Their evidence sometimes adorned a case, and gave rise to very agreeable and interesting scientific discussions; but, after all, it had little or no weight with the jury." It is also complained that, in such trials the medical evidence is too freely dashed with metaphysics. With respect to the first of these charges, I may remark that legal men seem altogether to lose sight of the important fact that legal ideas about insanity are formulated, even stereotyped, which the medical are not nor can be. Medical views are undergoing progressive modifications to admit new experience of the nature and bearings of this disease. And, with respect to the second, I must in candor say that, granting its correctness, the mistake it complains of is often chargeable to the besetting tendency of courts of law to drift into a sea of metaphysical discussion, and to pay undue attention to the theoretical side of questions of insanity. We may even trace this failing in the deprecatory remarks of the English judge just quoted, especially where he states that the evidence of experts in insanity "sometimes adorned a case, and gave rise to very interesting scientific discussions." These words exactly interpret the weakness to which men of curious minds are prone when they catch a scientist. They look upon him as a *rara avis*, with whom they are only too glad to have a few intellectual flights by way of mental diversion. The trial is, in a measure, suspended that the court may enjoy the luxury of "an interesting scientific discussion." During this interlude the lawyers rest from the fatigues of a hotly-contested combat, the jury draw a long breath of relief, the judge leans back in his chair, a pleasing, drowsy lull steals over the wearied court, and, in the general suspense, all eyes turn with pleasing anticipation to the rising medical luminary. When the *séance* is ended, the refreshed court applies itself with new vigor to the knotty question of the hour.

Judging by incidents frequently occurring all over the country, the plea of insanity would seem to be one of the most reckless morals which it is possible for lawyers to enjoy. Certainly they have far transcended the zeal of the medical profession in their efforts for the extension of its boundaries. What has attracted their special favor is the plea of moral insanity, a vague theorem, whose outlines are yet indistinct if not shadowy. Nevertheless, the legal profession experience no difficulty in asserting it in almost every man whose crime is of a startling character. Is a man clutched by the law after a life of successful villany, or does he commit a murder under the governing influence of passions pampered for years, or is he a hypocrite, he will find counsel ready to establish his moral insanity. And so it goes on until, finally, insane impulse will be the accepted cloak for crime, and the little moral restraint or obligation against wrong-doing that survives will be lost among this indifferent, self-seeking generation.

The danger is that the medical profession become inoculated with the foolish notions of the day on this subject, and so keep pace with the popular current. It is a thing to be regretted that they often give indiscreet adhesion to prevailing notions. Ignorant men do not: their ignorance, timidity, or earnestness leaving them to hug [illegible]. Lovers of progress have this weakness also, as the Athenians of old, they are ever running after something new. No doubt the temptation to overdo the matter is great both for lawyers and physicians—for lawyers because insanity is a plausible, an imposing defence: for physicians because the study is truly captivating, both in itself and by reason of its close affiliation to metaphysics—in which latter fact is a warning fear to many of the most gifted minds. Let us beware of hobbies, for the time may come when the use of the word will be confounded with its abuse, and both condemned together.

Its Obligations to its Professional Brethren.—Finally, I will briefly consider some of the duties of medical men to each other, as witnesses and otherwise in trials for malpractice. Allow me to introduce the subject by a hurried sketch of the legal nature of the business relation between physician and patient.

Prof. Ordronaux, in the able work I have already many times quoted, and for reference to which I am indebted to the kindness of our President,[7] states that "the character of a professional service is that of a mandate, and the obligations incurred under it, when no special contract has been entered into by the parties, belong to that class termed in the civil law *quasi ex contractu.*" In Wharton's "Lexicon," a mandate is defined to be "a judicial command, charge, or commission," having as necessary qualities, 1. Some object of the contract, *i.e.*, "some act or business to be done;" 2. That this act or business should "be to be done gratuitously;" 3. That the contract should be voluntary. Certain obligations were created on both sides by the mandate. On the side of the professional (mandatory): 1. "An obligation to do the act; 2. To do it diligently; 3. To render an account of his doings to the mandator. On the part of the mandator to reimburse the mandatory for all expenses and charges incurred in the execution of the mandate." I will pass over any further allusion to the mandatory character of the service, and merely content myself with calling your attention to what seems to be an error in the classification of the obligation—Prof. Ordronaux and Mr. Wharton placing it among *quasi* contracts, which they state to be implied contracts, while Mr. Maine, at p. 332 of his celebrated work on "Ancient Law," declares this to be an error: "For," he writes, "implied contracts are true contracts, which *quasi* contracts are not." The question may seem to have only speculative or historical interest, but in reality it has more, because if the relation between physician and patient be that of *quasi* contract only, which according to the highest authority of the day means no contract at all, it can have no definite legal obligations. If there be really the distinction between the terms as pointed out by Mr. Maine, I should prefer classifying professional contracts under the heading predicated by the word implied. And it is easy to trace in the early history of medicine, in Rome, the origin of this relation between physician and patient. The well-to-do class of the Roman people entertained a strong aversion to the physicians of their day who practised for money, as shown, among other evidences, by Cato's rudeness to the Greek physicians practising in the city, and his urgent admonitions to his son to avoid them and the study of their art. Actuated

by this aversion, which was mainly born of distrust, they disarded the services of qualified men, and relied chiefly on preriptions contained in such books as the "Commentarius," or n the empirical skill of trustworthy slaves or freedmen. Now, as, by the Roman law slaves and freedmen (when these latter were not citizens) were excluded from all civil rights, being "only subject and liable to duties" (Austin's "Jurisudence," vol. ii., p. 741), they were debarred from entering to contracts, though they would doubtless always receive an norarium for their services in so important a matter as the reservation of health. And, from always receiving the honrarium, they would come at last to have an implied right to t: thus the service being done, the honorarium would follow ts implied condition. The idea of the implied obligation of ofessional services passed into English common law—which we know to be chiefly derived from Roman civil law filtered rough canon law—and has lasted there even to the present me, two thousand and more years after the circumstances riginating it have ceased to possess a living meaning. And this day no member of the Royal College of Physicians can sue for his fees. But, in our country, this, like many more of the lifeless traditions of the past, has never been resuscitated. "Whatever," said Chancellor Walworth, "may be the practice of other countries . . . the principle never has been adopted in this State, that the professions of physicians and counsellors are merely honorary, and that they are not of right entitled to demand and receive a fair compensation for their services."—(Quoted from Ordronaux's "Jurisprudence of Medicine," p. 39.)

The physician or surgeon who undertakes the treatment of a diseased person has the following duties to fulfil: 1. He shall exercise ordinary skill and diligence; 2. He shall devote ordinary care and attention. You will remark the recurrence of the expletive "ordinary" in both of these injunctions. It gives an important interpretation to the meaning of the law. It is plain from the language of commentators that the meaning is not common, unlearned skill, but ordinary professional skill—namely, that average skill which results from having the necessary degree of professional knowledge. And again, it does not mean the ordinary skill of the great lights of the medical art, but that skill which is displayed in the practice and deemed necessary in the judgment of medical men

generally. Such is the meaning of the expression as applied to the general body of the profession; but for specialists, for those who claim a higher degree of knowledge and skill in their department than most other physicians, being employed on that account, and charging higher fees for their services, it has a particular meaning. It then signifies extraordinary skill by comparison with the ordinary skill of the profession, which is equivalent to ordinary skill as compared with the prevailing standard of skill among specialists.

Now, as skill implies the possession of knowledge, so the remaining requirements of the law have reference to the application of this knowledge. It is not alone required that the physician should display ordinary skill, he must also use ordinary care and diligence. The term ordinary, as a predicate of care and diligence, has the same force here, as when used with reference to skill; which is to say, it means that degree of care and diligence which is displayed in the practice, and deemed necessary by the collective judgment of medical practitioners. But further, it also means care and diligence proportionate to the difficulty or danger of the case. It is important to bear this last interpretation in mind, as teaching us how fully courts of law are alive to the fact that severe cases require one degree of ordinary skill and judgment, mild cases another; that what is ordinary skill in some cases is defective skill in others; that, in a word, the physician is to exercise skill, care, and diligence, in proportion to the gravity of the circumstances of each case. Besides the three qualities just mentioned, the medical practitioner is required to use his judgment as to the best means of effecting a cure. We all know that the end of medicine and surgery is the cure of diseases and injuries, but we sometimes forget that this end may be attained by different means, just as two travellers setting out from one starting-point may reach a given city by distinct roads. Nearly every physician and surgeon has experience of some particular and favorite method of attaining this end. There is not necessarily any uniformity among them in this respect, nor, in the interest of progress, is it desirable there should be. A return to the prohibitory laws of Egypt, which obliged practitioners to conform to the stereotyped rules written in the books of Hermes under penalty of capital punishment, would be a movement too reactionary for even the

most conservative of the present day. It is merely enjoined on the practitioner that he shall use his judgment in selecting proper means for effecting the cure of his patient.

At one time it was held that, if the practitioner escaped an indictment for gross negligence, he could not be judged guilty of malpractice. But, in reference to this interpretation, Judge Story remarked that there is no legal meaning attached to such an expression as "gross negligence," which could be made good in practice, and that the distinction it is said to denote is "utterly repudiated by the late civil law reports."

I believe there are few, if any, members of the community more conscientious or disinterested in the discharge of their duties than medical practitioners. Liable to be called at any moment to the most complicated cases, and expected to be prompt and decided in the application of necessary skill, their movements are suspiciously watched by critical eyes, and their words treasured up, it may be for the day of wrath, by attentive ears. Bearing the whole burden of a great responsibility in a serious case, they must often contend singly against its difficulties incidental as well as natural, sometimes without hope of reward if they succeed, but generally sure of unsparing condemnation if they fail. They who are familiar with this state of facts, and with the obstinacy, perversity, and ignorance of many to whom the services are rendered, cannot but feel a lively sympathy with the medical practitioner. But, when to this is added the lawsuit entered against him, maybe by the very person whom in his heart he felt he had most befriended—the sting from the serpent he had eased of suffering, or saved from death—his case appeals loudly not only for the moral support of the community, but equally for the material aid of his profession. Putting aside the loud boasters, the selfish, inconsiderate, and even ignorant men to be found in the profession, whose conduct may sometimes deserve the infliction of a lawsuit, I do not hesitate to assert that a very large proportion of actions for malpractice brought against medical practitioners are instigated by unworthy motives. Some, indeed, go further, asserting that were the secret history of such cases known it would unveil the promptings of malevolent professional rivals. This may be true, although I prefer to think not to the extent asserted. I have no doubt many lawsuits are unintentionally originated, or at

least encouraged by the indiscreet or inconsiderate judgments which medical men are too much in the habit of passing on the conduct and treatment of their professional *confrères* in presence of lay people. It is impossible to exercise too much caution in expressing opinions on the character of the professional services of a brother practitioner. Ten chances to one the listeners will misunderstand you, will take your criticisms without the qualifications with which you accompany them, will magnify their meaning and add to their substance, until a damaging and irritating grievance is built up against the intended medical victim. The rule of the physician should be *audi alteram partem*, and in all his dealings with men of his own cloth—and of all cloths, for that matter—to exercise more of that charity of which St. Paul speaks as thinking no evil. Besides, simple reflection should remind him how puerile it must be to accept as conclusive the statement of a patient or his friends, ignorant as they must be of the nature of the disease, of the difficulties attending its treatment; and who, in eagerness to establish their case, suppress those facts in their own conduct which would effectually tell against them. Recently I was asked my opinion on the result of treatment a former patient had undergone for a fractured collar-bone. Union had taken place, but the broken ends could be easily felt, and even plainly seen projecting beneath the skin, for they were overriding to the extent of fully an inch. To all appearances this was the most careless or the most ignorant surgery, and seemed, *prima facie*, to justify the threat of damages which he held dangling, like the sword of Damocles, over the head of his medical attendant. But, on sifting the facts, I found the result wholly attributable to himself. It appeared that several times during treatment he became intoxicated, tore the appliances off, and escaped from the control of his medical adviser and friends. If I had inconsiderately given an opinion of this case, if I had condemned its treatment, still another might have been added to the long list of vexatious and ruinous suits brought against members of the medical profession.

It is said that nine-tenths of the suits for malpractice are founded on the treatment of fractures, amputations, and dislocations; and the habit of bringing them is increasing so much that honest and capable surgeons have seriously de-

bated the necessity of retiring from a profession whose emoluments are so scanty in comparison with its risks, and in which the hard-earned reputation of almost a lifetime may be demolished in a day. I cannot altogether acquit the legal profession of some share in the production of this feeling of insecurity among medical practitioners. It is their duty, of course, to hear the complaints of their clients, but they should see to it that these complaints are justified by the facts, and they should acquire sufficient knowledge of these facts to enable them to judge whether, even if true, they justify an action which may entail such lamentable results. Have they such knowledge? I fear not. I fear they share to some extent, to too great an extent indeed, the popular error that whatever deformity results from a fracture is the fault of the surgeon. I think they are not sufficiently aware of the differences in the nature and termination of fractures; that, in their nature, they are simple and compound; that simple fractures are transverse or oblique; that oblique fractures are the rule, transverse fractures the exception; that the transverse get well without deformity, provided the patient obeys instructions, but that the oblique and compound almost invariably, and in spite of the most admirable surgery, leave shortening or other disfigurement; consequently, that most fractures only unite at the expense of the length or shapeliness of the limb. These, with other facts of a like character, have been established by Prof. Hamilton, of this city, who proved, by the result of investigations conducted in a rare and exemplary spirit of candor and impartiality, that, "in fractures of the tibia and fibula, both compound and simple, perfect results are in the proportion of only one to about three of the cases treated; and, in fractures of the femur and clavicle, complete cure results in about one case in five; in fractures of the patella, a perfect cure happens only in one case in six." Is it not time for the legal profession to have a knowledge of these facts? Is it not reasonable to hope that, with this knowledge in their possession, they will, even apart from moral considerations, lend the weight of their great influence to discountenance ruinous and vexatious conspiracies against medical practitioners?

At the Eleventh Annual Meeting of the Ohio State Medical Society held in 1856, the question of suits for malpractice was discussed, and it was asked, "What course shall the profession

take in regard to the matter?" "Severe implications," it was said, "are being meted out to our professional brethren on account of imperfections, resident, not in themselves, but in their art." And it was suggested as a remedy, that there should be among the profession a distinct understanding and general consent that brethren going through such suits are entitled to the "sympathy and assistance of as many of their professional" *confrères* "as may be necessary to sustain them," and that "if avoidable, no member of the profession should give his services to the prosecution." I willingly acknowledge the goodness of this advice, but at the same time I must say it is too vague to be applicable to a real emergency. Further, it seems to ignore the fact that there are unprincipled, self-seeking men in the hierarchy as well as in the rank and file of the medical profession. So long as this remains a sad truth, it will be vain to appeal to the "sympathy and assistance of as many professional brethren as may be necessary," etc. There must be some means uncontrolled by sympathy or other transient feeling; some certainty on which the surgeon can rely in that trying hour when he must face-round, and fight singly in a cause which is vital to the whole profession. That something is a professional fund of national extent to which all qualified medical men in the United States should be called upon to contribute, and which should be used solely for the purpose of defraying the legal expenses of such suits and of paying some at least of the damages inflicted. I cannot enter now into the details of this scheme, though at a future time I may be permitted to do so; suffice it for the present to say that it would be necessary to restrict such aid to those cases only wherein, in the opinion of a medical council duly appointed, it should be proved by careful examination of the evidence that the defendant had suffered unmerited accusation or punishment.

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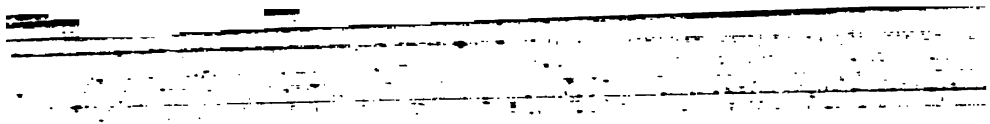

The Pathology and Treatment

OF

SCARLET FEVER.

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THE PATHOLOGY AND TREATMENT OF SCARLET FEVER.

GENTLEMEN: Of the acute diseases which are exclusively transmitted through the human body, scarlet fever, in relation to the health of the race, holds the first place, since the frequency of variola, through protective measures, has been reduced to a minimum. The old historical term "acute exanthema" is less and less frequently used, owing to our advances in pathological knowledge. Formerly, the eruption was considered the most important phenomenon; to-day it is looked upon only as a local manifestation of the infection, a localization of the infectious agent in the skin, which is strictly analogous to the localization of other infectious germs, as for instance in the pia mater in cerebro-spinal meningitis, in Peyer's patches in typhoid fever, in the colo-rectal mucous membrane in dysentery, etc. If, in naming this group of infectious diseases, we desire to grant the preponderance to the skin phenomena, then we may, of course, speak of the acute infectious exanthemata.

Scarlet fever, even as diphtheria, resembles the head of Janus—a harmless, friendly face in sporadic cases and in mild epidemics, but a terrible, war-like face in malignant epidemics.

You must not judge scarlet fever, gentlemen, from the relatively harmless course which it runs here in the hospital or even in the children's hospital. This perfidious disease must be studied in families, above all in the abodes of the poor, in small cities and in the country. There you will note and learn to fear the great malignancy of which it is capable. Scarlet fever in the large cities does not often occur with such frequency as to deserve the name of severe epidemic. In small

cities, however, in country districts where scarlet fever, like measles and diphtheria, only occurs epidemically every three to four years, there we may note how changeable in character the epidemics can be. After mild epidemics, the mortality from which varies from 2 to 4 per cent, there follows the most severe kind with a mortality of from 20 to 30 per cent. I have witnessed epidemics where one-quarter of those affected died, and where all the children of families were carried off. Such epidemics, so variable in phenomena, and so malignant in complications, must one see in order to mistrust the mild nature on which certain authors have laid stress. The so-called mildness of this infectious disease was traditional from the time of Sydenham, who first established the identity of scarlet fever, and who, from his observation of the great London epidemics of 1661 and 1675, deduced the conclusion that we were dealing with a *morbus sui generis*, in the treatment of which it sufficed to withhold from the patient meat and stimulating drinks, not to allow him to go into the open air, and that he need not stay in bed. Under such treatment, he says, "morbi nomen (vix enim altius assurgit) sine molestia aut periculo quovis facillime abigitur." Such was the definition of this disease given by one of the most learned and experienced physicians of the 17th century. In the middle of the 18th century, Haens' observations of a malignant epidemic in Holland (1748) taught differently. Still Sydenham's legend in regard to the mild nature of scarlet fever remained current, until a number of severe epidemics in the second half of the 18th century caused physicians throughout almost all of Europe to reach the conclusion that scarlet fever was an infectious disease, the epidemics of which might present the most variable characteristics as regards gravity.

It is proper in this place to note that the first description of scarlet fever did not originate, as is generally claimed, from Sydenham, but from a German physician and teacher, Professor Daniel Sennert, of Wittenberg, if we do not grant this position to Döring's description in 1625, that is to say about the same time as Sennert. Still, neither of these writers gave the affection a name, as did Sydenham. Sennert said that the eruption spread over the body like erysipelas, but that it resembled rather measles in that it only affected children and not adults as did erysipelas. Possibly, says Sennert, it is the

affection which Forestus calls purpura and rubores, and which according to Philip Ingressias the Neapolitans call Rosalia. The disease is represented by Sennert as being very serious and dangerous to life; Sydenham's optimistic view resulted from his personal observation, and he does not seem to have known of the work of his great predecessor Sennert.

"Malum hoc grave," says Sennert after a marked description of the course, "periculosum et sæpe lethale est. Nam calor et ferventissimus, sitis inextingibilis, et plerumque pulmonum, faucium et aliorum viscerum inflammationes, deliria et alia mala urgent. In declinatione . . . cutis squamarum instar decidit; mox pedes ad talos et suras usque intumescunt, hypochondria læduntur, respiratio difficilior redditur, tandemque abdomen intumescit ægrique non sine magno labore et post longum tempus pristinæ sanitati restituuntur, sæpe etiam moriuntur."

This careful description of scarlet fever resulted from Sennert's observations in the small town of Wittenberg. Even in his time epidemics of scarlet fever do not seem to have been of as malignant a nature in the large as in the small cities. In favor of this speaks Sydenham's assertion that scarlet fever scarcely deserved the name of a disease; and in favor of this also speaks Trousseau's description of Brettonneau's many years of observation. In twenty-four years (1799 to 1823) Bretonneau did not see a case of death from scarlet fever in his large practice. But in the twenty-fifth year he saw such a malignant epidemic as to cause him to throw overboard his opinion in regard to the mild nature of the disease.

We have no explanation to offer for this changeability in the character of the epidemics, and those which have been here and there offered are proved non-valid by statistics. The most plausible view is, even as with measles, that epidemics are so much the more malignant the less frequently people are exposed, that is to say, the greater the interval between two epidemics the greater the number of children ready for exposure to the influence. Against the universal truth of this view speak observations like those of Köstlin of Stuttgart, where, after a period of sixteen years' (1830 to 1845) freedom from scarlet fever, the first epidemic, that of 1846, did not cause a single death, neither did the next epidemics in the beginning of 1850 appear especially malignant.

The season of the year, atmospheric changes, age, sex, do not seem to have any special influence on the character of the disease, and we cannot here, any more than in case of the indirect contagious infectious diseases, claim that locality has a greater or less influence on the virulence of the infectious germs. I have often noted that in many families the disease will affect all the children, while in other families, in the same epidemic, there will only occur a few light instances of the disease.

The disposition to scarlet fever is very variable. Nurslings are very slightly disposed to the reception of the contagion, and even in the years of greatest disposition, two to five, many children escape and remain unaffected their entire life. We cannot lay stress on the influence of constitution, nor of the often mentioned social condition, since in epidemics it has been noted that children of wealthy parents may be more frequently affected than those of the poorer classes.

It must be granted that adults are less likely to be seriously affected by scarlet fever than children; still I have seen a number of deaths from the disease in adults. For example, of the 492 cases of scarlet fever, affecting almost entirely adults, which occurred in the general hospital at Munich from 1865 to 1887, the mortality was: 1865 to 1875, 113 cases, with 13 deaths (11.5 per cent); 1876 to 1887, 379 cases with 5 deaths (1.3 per cent) only.

One attack of scarlet fever protects the organism for life against the infection. Exceptions to this rule are rare, and then usually it is because people who in their youth had scarlet, later, during the sickness with scarlet of a young sister or of children, are affected by a mild fever (feverless exanthema, feverish angina).

The disease factor, the infectious agent, is as yet unknown. It cannot be doubted that it is a *contagium vivum*, and that it may be figured as being a minute form of life; still, notwithstanding the positive results from inoculation of the blood of scarlatinous patients in healthy persons, we have not yet detected a distinct germ as the carrier of the scarlatinal contagium.

Among the peculiarities of the infectious material its tenacity is especially established. For months, without losing its virulency, it may cling to clothes, bedding, house utensils,

the walls of the dwelling. The usual methods of disinfection of dwellings, furniture, etc., seem here to be powerless. We can only depend on freeing from the infectious material those articles of attire and of furnishing which can be exposed for long to steam.

It being granted that the infectious material may be carried in the clothing and in books, so also must it be deemed possible for healthy people who have been in contact with diseased, to carry the germs on their hands, in their hair, or clothing. That such people should themselves become diseased is not essential, on the contrary it is usually impossible, since they are ordinarily adults who have already passed through the disease. The families of physicians seem particularly to be endangered. The frequency of scarlet-fever infection in schools, is due to this tenaciousness of the contagium. It is patients convalescing from scarlet fever who transmit the infectious material to the air and clothing of their fellow-scholars, and not children in the invasion period of the disease. The latter, indeed, on the appearance of the invasion phenomena of the disease, are sent home at once, and remain, therefore, in this stage, in only brief contact with the other pupils. It is further questionable as yet, if scarlet fever in the prodromal period gives off infectious material. In this respect scarlet fever differs materially from measles. In the latter the prodromal stage lasts for a number of days, and the children, although suffering from catarrh and fever, are frequently enough sent to school. It cannot be doubted that the secretions and excretions of patients suffering from measles are contagious even in the prodromal stage.

In regard to the duration of the incubation or the latent stage, the most reliable observations speak for seven days as being the usual one, but then cases occur where this stage is double this time, and others where even a few days after infection the disease breaks out. We cannot explain this irregularity in the duration of the incubation period and must leave this to further research. As far as we know as yet, scarlet fever is in this respect peculiar. Since all external and individual influences are effective in case of the remaining infectious diseases whose incubative periods are cyclical, they must also be in case of scarlet fever, and so we must seek for the reason in the variable developmental property of the scarlet-fever poison.

Ordinarily, during the period of invasion, there are no phenomena characteristic of the disease. Occasionally slight constitutional disturbance and angina are noted.

The invasion picture of the disease, the breaking out, or the prodromata of the disease, as it was the custom to call it when the eruption was deemed the chief thing, are very striking. Vomiting, angina, fever, this trinity ushers in the scene. The onset of the fever may be variable; chill is exceptional, chilly sensations are more frequent. Frequently in children a convulsive attack is the initial symptom in place of the chill. This is the case in children not only in scarlet fever but in all acute fevers, particularly in croupous pneumonia.

The temperature quickly rises and on the same day reaches 40° to 40.5° C. The pulse is markedly quickened, in children reaching 140 to 150. These severe disturbances in the central organs, the heart and the temperature regulation apparatus, react ordinarily on the general nervous system. The child not only goes at once to bed, but is relaxed, prostrated and strikes the physician as being very sick.

The diagnosis in this stage, which precedes that of eruption, is often doubtful, especially if it be the first case in the family. I must again lay stress on the diagnostic value of that triad of symptoms which accompany the onset. Ordinarily the following is the sequence: the child comes home at evening, from school or from the garden, complaining of sore-throat, goes to bed, has a chill, and when the physician arrives and takes the temperature he finds marked increase in the body warmth, together with frequency of the pulse and severe general disturbance. Ordinarily on the evening of the first day or on the second day, the eruption appears and makes the diagnosis, but still, in view of the essential separation of the sick from the well, it is very important that the diagnosis of scarlet fever should be made as early in the disease as is possible. The repeated, uncalled-for vomiting has always seemed to me a most important diagnostic symptom, where pneumonia, from the absence of physical signs, can be excluded. Often, however, the vomiting is absent, and so also may the fever or general disturbances, or angina may not be pronounced. In such cases we must be reserved in our opinion and wait for the appearance of the eruption; for safety, however, the healthy should be isolated from the sick.

The eruption appears on the evening of the first or on the second day, most marked at first on the throat, breast, and back, the face usually being free from it. Here we have an essential differential point from measles and small-pox. The cheeks and temples and ears are ordinarily highly reddened from fever, and not infrequently covered by the eruption, but the neighborhood of the mouth and the chin are usually very pale and this contrasts markedly with the deep red of the neck. This appearance is very characteristic. The beginner, who usually finds it difficult to reach a diagnosis in case of the acute exanthemata, a difficulty which in the beginning of one's practice is very suggestive to the parents, may generally reach his diagnosis by remembering this contrast in connection with the symptoms of the period of invasion. There next appears the characteristic scarlet coloring, the raspberry tone of the exanthema, which is readily recognized even under artificial light. The form of the eruption, from the beginning, in small spots not elevated above the uncolored skin, the rapid confluence of the spots, the islets of pale skin between, the relatively quick spreading of the eruption over the back and the extremities, which usually happens in two days, these are phenomena which are peculiar to scarlet fever. To determine the color of the eruption it is advisable, after quickly uncovering the warmest part of the skin, in particular the nates, to glance at it from a distance and to test the inflammatory hyperæmia by pressure with the finger tips. Even in case of relatively slow development of the eruption, as in instances of aggravated infection, the peculiar dark and finely disseminated redness strikes the eye. The vaso-motor, in particular the vaso-constrictor nerves, owing to the manifest dilatation of the capillaries, are in a state of great mechanical irritability; contact with a resisting agent causes them to react by a spastic narrowing of the vessels in the irritated zone. By stroking the scarlet skin, letters and figures may be formed, a phenomenon which Bouchut claims to be pathognomonic of scarlet fever, since in no other form of inflammation of the skin is this possible to such a marked degree.

Desquamation, which ordinarily begins the sixth day on the throat and thence spreads along the course of the eruption, is characterized by the large scales of epidermis which are shed. This lamellar or membranous desquamation is

pathognomonic of scarlet fever, and leads to diagnosis weeks afterward, a factor which is most important for the establishment of the scarlatinal nature of nephritis as also for prognosis. The desquamation is most extensive and lasting on the feet and hands, on the palms and soles as well as the fingers and toes. Intense exanthema is regularly followed by marked desquamation. In adults especially, we may see the epidermis of the whole hand shed in one piece, and the skin of the fingers is often cast like the finger of a glove.

The length of the desquamation period is very variable; it may last for weeks and this wearies the patient as much as the physician, since return to customary habits is not advisable until the desquamation is at an end.

The angina, usually the first symptom of the disease, is at the outset ordinarily not different from simple catarrh. The injection and swelling of the mucous membrane of the isthmus of the fauces is either an even one or else spotted, extending to a greater or less degree over the velum, and the swelling of the tonsils and of the lymph glands is marked. In severe cases the swelling may attain a high degree, so that in young children it may lead to difficult respiration through stenosis of the isthmus. Even though the closure of the naso-pharynx is incomplete, nasal tones and regurgitation of fluid into the nostrils occur.

The appearances in the throat are very characteristic, and scarlet fever causes pathognomonic changes of the tongue, such as great injection and swelling of the papillæ. The filiform papillæ stand out at the apex and on the borders of the tongue like slender shining red pearls above the epithelial layer. The appearance is very pretty, and the scarlet fever tongue has been called the raspberry-tongue, the cat's-tongue. Under circumstances these appearances may be of diagnostic importance.

Very frequently a purulent inflammation of the nasal mucous membrane accompanies severe cases of scarlet fever. We cannot always be sure as to whether we are dealing with a purulent catarrh or with diphtheria of the nasal mucous membrane. This catarrh is in all cases a bad phenomenon, since it points to great inflammation of the naso-pharynx and nostrils.

Ordinarily the fever remains for two to three days at the

height reached on the first or second day (between 40 and 41° C.) and then it gradually sinks. At the end of four to five days the temperature reaches normal, although into the third week, through the entire desquamative period, there is a slight evening rise. It seems as though an extensive desquamatory process were the cause of this fever; still retrograde metamorphosis in the internal organs, in particular the glands, might be at the bottom of the febrile disturbance.

Implication of the nervous system may be very variable, but it is never lacking. This varies according to the nervous disposition of the individual; nervous children readily grow delirious; phlegmatic children are only quite sleepy. The extent of implication of the nervous system also varies with the virulence of the poison, the action of which on the central nervous system may at times be very deleterious. I will return to this point when I speak of the anomalies in the course and of the complications of scarlet fever.

The course of scarlet fever then is run, even in mild cases, in a turbulent way for six to eight days; the whole period, however, including the desquamatory stage, from the beginning of the disease to return to ordinary life, requires at least three to four weeks.

The diagnosis of the affection when it runs a normal course is not at all difficult if all the factors are borne in mind. As easy, however, as the recognition of the disease is ordinarily, just as difficult may it be in the sick-room when all history and prodromal symptoms are lacking. In many such cases it is impossible to make a diagnosis from the frequently insufficiently developed eruption alone. Nevertheless, I cannot impress upon you sufficiently, gentlemen, the importance of carefully studying the eruption in order to note all that may be gathered from its appearance. You must see as many cases of scarlet fever as possible. Large hospitals and clinics, especially the skin divisions of the Vienna general hospital, give you this opportunity. And, gentlemen, let it be your rule in examining any eruption to note first always the general appearance and to feel it, and next to search for the primitive form of eruption at the periphery in order to determine whether it is spotted or nodular, etc. I take this opportunity to lay stress on the inferior place granted dermatology in many of the German high schools, and, on the other hand,

I must lament the difficulties in private practice which beset the physician who, as is customary, has not been thoroughly trained in the diseases of the skin. We cannot study these diseases in books; this study must be on the living; no atlas can take the place of observation at the bed-side. Further, the variety of diseases of the skin which the student sees in his clinical semester, is too great, and, in consequence, bad errors are made in practice as well in diagnosis as in treatment. Generally the student has a certain disinclination to study the diseases of the skin; the majority of physicians do not attend any lectures nor read any works on this subject, although the study of skin diseases has a very great theoretical and practical value. Every physician who desires to feel at ease in the sphere of dermatology should, after completion of his curriculum, resort to some metropolis, in the hospitals of which he may under expert guidance study a vast material. I repeat then: seize every opportunity to see and to study the diseases of the skin, this brings ease in practice owing to the greater certainty in diagnosis and the better results of treatment. When, gentlemen, I lay stress upon this, it is because I am convinced that recognition of the exanthemata is only secured through repeated observation. At the end of my lecture, therefore, I present a case to you that each may have the opportunity to see and study the case closely.

I will recapitulate here the points in the history of the case you last saw, which we may consider an instance of the normal course of scarlet fever:

C. W., a factory operative, æt. 20, on the morning of the 20th of July was seized with chill, nausea, vomiting, headache, and dysphagia. The evening of the same day the symptoms were general pains, great restlessness, severe headache, painful angina. The pulse was full and hard, 152, the temperature 40.1°.

July 30th (2d day of disease). In the morning, after a very restless night, the general disturbances were no better, the angina being worse; red spots on the temples, cheeks, and neck appeared. In the evening the eruption had spread over the entire back. The condition otherwise was unchanged. P. 142, T. 40.4°.

July 31st (3d day). In the morning the eruption was more markedly developed; otherwise the condition was the same. P. 132, T. 39.4°. In the evening, P. 132, T. 40.2°.

August 1st (4th day). In the morning the eruption had spread thoroughly over the extremities; the angina was worse, the urine normal. P. 112, T. 39.4°. In the evening: Condition was the same. P. 120, T. 40.1°.

August 2d (5th day). In the morning the eruption was fading from the back. P. 100, T. 38.6°. In the evening the same condition. P. 112, T. 39.6°.

August 3d (6th day). In the morning desquamation had begun on the face and neck. P. 80, T. 37.4°. In the evening condition the same. P. 96, T. 38.4°.

August 4th (7th day). In the morning the angina had almost entirely disappeared; desquamation general. P. 96, T. 38°. In the evening, P. 96, T. 39.

August 5th (8th day). In the morning, P. 84, T. 37.8°. In the evening, P. 104, T. 38.7°.

August 6th (9th day). In the morning, P. 80, T. 37.3°. In the evening, P. 90, T. 38.2°.

August 7th (10th day). In the morning, P. 66, T. 37.6. In the evening, P. 62, T. 38°.

August 8th (11th day). In the morning, P. 66, T. 37.4. From this time forth, no more fever, a speedy convalescence.

This, gentlemen, was an instance of so-called normal course of scarlet fever without complication. The period of fever lasted just eight days, and four to five of these days belonged to the period of desquamation.

I will now relate the history of a case where, during an otherwise mild course of the disease, there occurred eclamptic attacks during the height of the fever.

E. K., æt. 2, a strong child, previously healthy, passed a very restless day from the 10th to the 11th of July.

July 11th. In the morning, aggravated general state, finely spotted eruption on the temples, cheeks, neck, and back. Mucous membrane of throat very much reddened uniformly and swollen. Dysphagia was absent, as also swelling of the glands. T. 38.4°. In the evening, general disturbances, somnolence, cheeks very red. Two stools. P. 172, T. 40.2°.

July 12th (A.M). Very restless night; great heat of body, much thirst; two attacks of general convulsions, each lasting one-quarter hour. Intellect unclouded, less restlessness, normal pupils. No swelling of the glands of the neck, eruption over entire body. On face slight desquamation; urine

straw-yellow in color, no albumin. P. 164, T. 38.7°. In the evening high fever; two slight convulsive attacks. P. 168, T. 40.1°.

July 13th (A.M.). Not specially restless during the night; no convulsions; eruption fading from the back, blooming on extremities; desquamation on face. T. 38.6°. In the evening, complains of itching; one stool at noon. P. 140, T. 39.6°.

July 14th (A.M.). Very restless night; P. 140, T. 38.6°. In the evening, P. 132, T. 38.2°.

July 15th (P.M.). P. 136, T. 38.7°.

From 16 to 20th of July progressive desquamation; highest range of temperature being in the evening of July 17th, when it reached 39.1°.

From the 20th on, undisturbed convalescence.

In the following case we note, together with a rather mild course an unusually long prodromal stage (forty-eight hours), pain in the joints, and dropsy without kidney disease. The latter phenomenon is usually rare, and resulted in this case from exposure before the end of desquamation.

W. T., æt. 10, a weak child, complained the evening of July 7th of pain in the throat and chilly sensations. Rested badly during the night.

July 8th (A.M). Patient out of bed till 11 o'clock, and then complained of chill and vomited a number of times. In the evening the face was uniformly reddened, no certain eruption, however, dysphagia slight, considerable angina, slight painful swelling of the glands of the jaw. P. 148, T. 39.8°.

July 9th (A.M.). Very restless night, but, notwithstanding, the general state is good. Dysphagia and swelling of the gland are greater; the mucous membrane of the pharynx is deep red, covered in parts with yellowish mucus; no diphtheria. Urine negative. P. 116, T. 38.1°. In the evening: increase of the fever, thirst, and an eruption which has spread all over the back and is well developed. P. 136, T. 40.4°.

July 10th (A.M.), slept much during the night; less pain in throat, appetite greater, eruption on face, especially lips and eyebrows, beginning to desquamate. P. 116, T. 38.6°. In the evening, is more feverish; desquamation marked on lower part of limbs. P. 128, T. 39.6°.

July 11th (A.M.). The night has been restless from itching; dysphagia less, and general state improved; good appetite;

constipation; eruption only noticeable on the lower extremities. P. 112, T. 39.6°. In the evening, the itching continues; eruption is more marked on the lower extremities, P. 100, T. 38.3°.

July 12th (A.M.). Stool during the night; sleep disturbed by pain in the wrists and in the back; eruption still visible on the nates. Both wrist-joints are painful on pressure and motion, but they are not swollen, nor are the hands reddened; the dorsal region is also painful on pressure. The urine, by catheter, is clear and free from albumin. P. 100, T. 38.3°. In the evening, T. 39.1°.

July 13th (A.M.). Slept well; wrist joints very painful, dorsal pain less, desquamation over the face. P. 96, T. 38.3°. In the evening, great weakness, great pain in joints and in back, swelling of glands has disappeared, urine is normal. P. 92, T. 38.8°.

July 14th (A.M.). Less pain. P. 84, T. 38.2°. In the evening, conditions the same.

July 15th (A.M.). General desquamation; pain in joints disappearing.

July 17th (A.M.). No fever, desquamation proceeding.

July 22d. The desquamation has progressed to the extremities and the skin is thence shed in large lamellæ.

July 25th. In the absence of his parents the child left the house and played out of doors for a number of hours. On July 27th œdema of the face, and this increased to July 28th. The urine contained no albumin, no blood, no casts.

The œdema disappeared in a few days, and the convalescence was thereafter normal.

The course of the fever during the three weeks is noteworthy. As usual, this fever is markedly remittent, the exacerbations appear with the desquamation. The pain in the carpal and the metacarpo-phalangeal joints was also remittent, there occurred no swelling of the joints. These pains in the joints are to be looked upon, even as is the eruption and the angina, as due to a localization of the scarlet-fever poison, and are of no importance from the standpoint of prognosis. To call this affection rheumatism, *rheumatismus articulorum acutus scarlatinosus*, is not appropriate, since we are not at all dealing with a rheumatic process. The desquamation on the face where there had been no eruption is frequent enough,

and is to be laid to specific infection of the papillary bodies. Finally, the occurrence of œdema of the face during the desquamation period without kidney disease is noteworthy. Such œdema without disease of the kidneys or heart is very rare, although I have often seen it. A young patient under treatment in the Greifswald hospital had great œdema, during the desquamation period, of the entire body, with uniform swelling of the scrotum and penis, in the absence of kidney or heart disease. The explanation of this dropsy as being due to the action of cold, is not a clear one; we must, however, believe in great irritability of the blood-vessels of the skin, of the vaso-motor nerves, as adjuvant causes.

The above are, in general, gentlemen, harmless anomalies in the course of scarlet fever. Let us now consider, before passing to a study of severe cases, the course of the mildest and abortive form of scarlet fever. I remarked in the beginning that during the course of an epidemic, people who are protected by previous attack and are busied around the sick will have rudimentary symptoms, such as angina with fever, or exanthema without fever, slight rheumatoid symptoms with angina, etc., and that such symptoms indicate slight infection. Such rudimentary phenomena of an infectious nature are witnessed during the course of all the epidemic infectious diseases. Call to mind the gastric febrile attacks during epidemics of typhoid, the symptoms during epidemics of cholera, the painful and frequent angina during epidemics of diphtheria, etc.

The following brief history is an example of such abortive attacks.

F. V., æt. 12½, a strong boy, who had never had scarlet fever, slept in a small room with his sister who was suffering from the disease. On September 21st the sister had the prodromata of scarlet fever and on the 23d the eruption appeared. The boy remained healthy up to September 30th. On October 1st he awoke with pain in the throat, nausea without vomiting and he did not care to get up.

The evening of October 1st he complained of dysphagia, the tonsils were dark-red and swollen, as also the glands of the angle of the jaw. The pulse was 120, the respiration 36, the temperature 40° C.

October 2d, in the morning, the boy was well and had to be called in from the street in order to be examined. The

angina, was still present; the subjective disturbances had disappeared. He had a good appetite. Pulse 94, temperature 37.6°. He remained well.

Another patient had a slight attack, although it was followed by a severe nephritis. We could also determine the incubation period in his case. He slept in the same bed with his six-year-old sister. She was taken sick on May 5th, and on the 6th the eruption appeared. The boy sickened on May 11th, that is on the 6th to 7th day after his sister. The fever lasted only five days, and reached 40° C. once in the rectum.

In practice among the poorer classes, where the parents are not specially watchful over the children, I have found children playing on the street and suffering from severe scarlet fever, and yet the thermometer did not show much increase in the body warmth.

Our present knowledge only allows us to theorize as to the reason of such differences in the action of the same morbid cause. Is it the quantity of the received infectious germs, or is it their primary virulence; or is it the individual susceptibility of the human body which in one case withstands the qualitative and quantitative development of the germs, and in another allows them to remain capable and to develop slowly or quickly? The latter supposition explains better, in general, the facts of experience and experiment at our disposal. The peculiarity of the germs in the dissemination of the products of infection which in the development of the same disease cause such variety in phenomena, must be claimed as depending on the state of the soil in which they effect lodgment. At any rate it must be granted that there occur differences in the primary virulence, in the malignancy of the infectious material. In favor of this speaks the severity in the beginning of great epidemics, and, as I pointed out before, the influence of locality on the severity of the disease has not been proved, in the sense that Pettenkofer claims. The correctness of this view is proved by erysipelas, where the invasion point is known and the local progress of the inflammatory causes can be controlled by the eye. We witness here, on the one hand, extensive dissemination of the erysipelatous inflammation and swelling associated with great constitutional disturbance, high temperature, severe brain symptoms; on the other hand, in another case there exists similar spread-

ing and intensity of the inflammation and yet no brain disturbances and almost no fever appear. I have often shown you such cases. The future will teach us if cultures from such mild cases of infection when inoculated produce different symptoms or cause different changes than germs from severe cases of infection. Many questions of the highest importance from the standpoint of treatment face us here.

Experience teaches us in regard to the action of severe infection that this affects above all the central nervous system, but that all the other organs suffer through the deleterious action of the poison on the nourishment and innervation of the cells and that they suffer the more the severer the infection. The number and gravity of these poisonous effects, which are called complications, vary in the different infectious diseases. No infection, however, equals scarlatina in this respect; in no infectious disease, except cholera, do such severe phenomena of infection present themselves in such a relatively short time, often indeed in a few hours; in none are the number and manifold nature of the complications as great as in scarlet fever.

Let me mention here a few cases of deep infection where the speedy fatal issue must be looked upon as due to sepsis.

Rosine M., æt. 4½, quite a robust-looking child, sickened on August 11th of vomiting, faintness, headache, fever and thirst.

On August 12th (P.M.), coma; small, soft pulse; severe angina without diphtheria; great swelling of the glands at the angle of the jaw. P. 130, T. 40.2°.

August 13th (A.M.). Very restless night; coma lasting; vomiting toward morning; on the back and chest slight eruption of scarlet fever. Pulse very small, frequent and irregular. P. 184, T. 41.9°. In the evening, at 3½ o'clock, death from eclampsia.

At the autopsy there was found purulent infiltration of the tonsils, simple swelling of the glands of the neck and of the mesentery; hyperæmia of the brain substance and membranes; enlarged spleen.

Julius H., æt. 5, a weak, poorly-nourished boy, who during a year has been treated for scrofula, pneumonia, and intermittent, slept in the same bed with his sister, who had scarlet fever November 11th. On November 19th, Julius was still healthy, but during the night he was very restless, and vomited a number of times toward morning.

November 20th (noon), he was deeply affected. Complained of great headache, much angina, his nose was stopped; there was an eruption over the breast, back, and upper arms. The pulse was small and very frequent, 110.

At night, the eruption had spread over the whole body, P. 100, R. 40, T. 39.7°.

November 21st (A.M.). During the night he grew gradually worse, being delirious. Lies in coma with stertorous breathing. The angina and swelling of the glands have greatly increased. No diphtheria. Eruption is weaker and livid. P. 190, R. 50, T. 41.3°.

At 5 o'clock in the evening had convulsions and in a half hour was dead. No autopsy.

In order to compare the anatomical with the clinical picture, I report the following two cases briefly where death occurred a few days later than in the preceding.

Christian E., æt. 2, a well-nourished boy, on the 30th of January presented the prodromal symptoms of scarlet fever.

January 31st (P.M.) came under treatment. Eruption already present on the neck, chest and back. Considerable angina and great general disturbance. P. 144, T. 40.3°.

February 1st (A.M.). Was somnolent and deeply infected, the spleen was greatly enlarged. The eruption was a trifle livid, the pulse small and soft. P. 160, T. 41.3°. In the evening, P. 148, T. 41.1°.

February 2d (A.M.). Had passed a restless night; somnolence continuous; delirium; P. 160, T. 40.9°. In the evening, condition the same; urine free from albumin; P. 162, T. 40.7°.

February 3d (A.M.) great delirium in the night; is comatose, although he can be roused. The eruption is pale-brown in color, great angina, no recognizable diphtheria. Under the left ear there was a small, hard, painful gland. A little cough; examination of lungs negative. Resp. 40, P. 152, T. 40.9°.

At 7 o'clock in the evening, was deeply comatose. At 12 midnight, death.

Autopsy, February 4th, at noon: Considerable injection of the membranes of the brain; brain substance soft, pale, especially the borders. The pleural cavities were empty, the lungs free, with a few small ecchymoses here and there. The mucous membrane of the smaller bronchi was reddened and covered with thick mucus. A few ecchymoses in the pericardium.

The right heart contained fluid blood and soft clots. Little blood in left heart. The valves were normal, the muscle relaxed and a trifle pale.

The velum was covered posteriorly with fibrinous exudate and under this were punctiform ecchymoses. The pharyngeal mucous membrane was injected, covered with grayish deposit and punctiform ecchymoses. The mucous membrane of the œsophagus, larynx, and trachea was injected. The gland on the left side of the throat was softened in the centre. The liver was normal in size, the surface smooth, the substance reddish-brown, rich in blood. The gall-bladder was distended with thin gall. The spleen was greatly enlarged and the substance pale-violet in color. The gastric mucous membrane was pale, with many erosions; the mucous membrane of the small intestines was a trifle injected, of the large intestine markedly so, and the solitary follicles were sharply punctate. Certain of the mesenteric glands were swollen, their substance soft, and pale grayish-red in color. The kidneys were quite large, the cortex grayish-red, the pyramids pale. In the pelvis of the kidney there was thin gray mucus.

Max F., æt. 2½, a strong boy, suffering for about eight weeks from catarrh of the mouth and ptyalism, was taken sick on the 16th of August at noon with headache, fever, and vomited three times.

August 16th (P.M.). Was somnolent; the cheeks were red, and the chin, temples and neck were covered with discrete scarlet spots. He had great angina, the angular glands were swollen and painful, the spleen was enlarged; there was no evidence of diphtheria. Examination of the lungs and kidney was negative. P. 156, T. 40.7°.

August 17th (A.M.). The night had been restless; had had two slimy stools, the ptyalism had ceased. Intense dark, spotted eruption over the entire body. Two enlarged glands on the left of the neck. P. 172, T. 40.7°.

In the evening, had been somnolent during the day, had been excessively thirsty, had had a number of brown, fetid stools; the eruption was dusky-red, confluent on the back, discrete on the extremities. The faucial mucous membrane was deep red, swollen, covered with slime; no diphtheria. Urine was dark and contained no albumin. P. 148, T. 39.8°.

August 18th (A.M.). Had had a very restless night; was

comatose, picked at the bed-clothes, had no control over rectum or bladder. The eruption on the face and back was paler, on the extremities it was still dark-red; the lips and cheeks were desquamating. The lips were dry and fissured. P. 160, T. 40.8°.

In the evening there was coma, jactitation, sordes on teeth. Had two diarrhœic stools. The eruption on the extremities was grayish red. P. 148, T. 39.8°.

August 19th (A.M). Been very restless during the night; had had one loose stool. Is comatose. The eruption over the body is again marked and dark red. P. 160, T. 40.8°.

In the evening the coma still existed, jactitation, occasional nausea, and grinding of the teeth were present. The eruption was pale. Had an involuntary stool; the urine contained no albumin and no sediment.

August 20th at 6½ o'clock he died after a restless night.

Autopsy, morning of August 21st: Great hyperæmia of the pia, marked œdema and hyperæmia of the brain substance. The muscles dark-red, and relaxed. The blood dark and thin. Heart muscle relaxed; the spleen enlarged, 2.5 inches long, 2.3 inches broad, 1 inch thick, dark steel-blue in color, rather soft, the capsule much distended. On section the pulp was dark red. The kidneys were slightly enlarged, 3.12 inches in length, 1.5 inches in breadth, 1 inch in thickness, the capsule readily removed, the surface smooth, pale, the pyramids pale red in color. The mucous membrane of the pelvis was injected. In the intestines there was swelling of the solitary follicles, the vermiform appendix was resistant, its mucous membrane thickened and largely ulcerated, no stone or other foreign body in it.

From these cases the anatomical and clinical picture of severe uncomplicated scarlet fever is clearly evident. The elevated temperature, the high pulse rate, the severe nervous disturbances, the dusky red and even livid eruption, the more or less intense angina, the gastro-intestinal disturbances and the splenic tumor, these are the characteristics of the clinical picture. The anatomical picture is represented by the hyperæmia of the brain and its membranes, the frequent œdema of the brain, the dark fluid blood containing only a few clots, the relaxed heart, the swelling with, usually, purulent infiltration of the tonsils and glands of the neck, the implication of other

glands in the body, the changes in the spleen, the ecchymoses in the serous membranes and the skin, the enlargement of the liver and of the parenchyma of the kidneys. The histological appearances consist in cloudy swelling of the parenchyma cells, etc. In regard to the rôle which parasitic elements play we know nothing as yet with certainty. Different varieties of germs, as well cocci as bacilli, are to be found, but the pathogenetic germ has not yet been discovered.

More frequent than these severe cases of uncomplicated infection are those instances accompanied by inflammation and necrotic processes of the glands of the neck, of the interstitial tissue of the neck, of the mucous membrane of the nose, the Eustachian tube, or the middle ear. These instances constitute the majority of deaths in malignant epidemics, and my rich material contains many cases of this nature.

The importance of these complications and their relation to the primary scarlet-fever infection are increased markedly by the almost regular occurrence of diphtheritic changes in the mucous membrane of the fauces and of the neighborhood. Latterly the diphtheritic nature of this affection of the mucous membrane has been questioned, and it has been considered rather as a specific ulceration of a scarlatinal nature. The opinion of the majority of physicians is against the view that we are here dealing with a secondary infection by diphtheria germs of the mucous membrane affected by scarlet. I must grant that many of my observations admit of no other explanation than that of a tendency of the specifically affected scarlatinal mucous membrane and glands to necrosis. Yet it is going too far when the attempt is made to exclude diphtheria entirely as a complication of scarlatinal angina. The reasons for this latter attempt, namely, that there is no tendency to extension to the larynx and that there is absence of after-paralytic symptoms, although correct, cannot be held as conclusive, since both laryngeal diphtheria and paralyses have been noted; I have myself seen a few instances, and then again there is a possibility that the diphtheritic poison suffers some change owing to its combination with the scarlet-fever poison, or, finally, we may be dealing with a variety of diphtheria different from the usual. We must grant that the poison of diphtheria is not unique, and that there is a possibility that the disease processes which we to-day call laryngeal

diphtheria, pharyngeal diphtheria, diphtheria of the intestines, etc., are due to different infectious germs and are only similar in gross anatomical appearances.

It is a fact familiar to every one who has seen many cases of scarlet fever in its malignant form and who has specially studied the subject both clinically and anatomically, that in the vast majority of cases of severe scarlet fever, associated with the hard infiltration of the glands of the neck and of the cellular tissue with tendency to necrosis, after death those changes are found in the pharynx which are peculiar to diphtheria, that is to say, not alone hyaline degeneration of the epithelium and of the sub-epithelial layers of the mucosa, but also fibrinous shedding of varying depth, patches separable from the mucous membrane, as in the case of Christian E., which I noted, where there was present a fibrinous exudation layer behind the velum. We must grant, gentlemen, that the differentiation in regard to the nature of the effective infectious germs here at work must be left to bacteriological research.

If now we consider the clinical picture of the severe cases of scarlatina with diphtheria, we find numerous coincident phenomena. We note the high continuous fever, the extreme frequency of the pulse, the aggravated affection of the sensorium, the jactitation, the stertorous respiration due to narrowing of the isthmus faucium, the fetor of the breath, the diphtheritic deposits on the fauces, the hard painful swelling of the angular glands, the infiltration of the cellular tissue of the neck and oral cavity fixing the head backward and rendering moving of the neck impossible. If the patient survive long enough, not only does the infiltration of the tonsils become purulent, and this may happen in a few days, but the glands and the cellular tissue undergo necrosis, which leads to extensive destruction, to erosion of vessels, to septicæmia, etc., which may end in death, and frequently enough does. I have met with a very large number of instances of this nature and will relate a few typical cases.

Catharina H., æt. 4, a weak child, has been ailing since February 1st, with headache and loss of appetite. The morning of February 3d she vomited a number of times and had two diarrhœic stools. In the evening the first eruptive spots appeared on the neck and chest. She complained of angina

and the constitutional disturbance was quite severe. P. 140, T. 40.6°.

February 4th (P.M.). The eruption had extended over the entire back. No diphtheria; general symptoms aggravated. P. 144, T. 40.1°.

February 5th (P.M.). Somnolence, eruption richly developed, deep red; angina worse; fine diphtheritic deposit on right tonsil. No albumin in urine. P. 144, T. 41°.

February 6th (P. M.). Eruption beautifully developed over entire body; diphtheria of both tonsils; swelling of the angular glands on both sides, particularly on right. General disturbances very severe. Ordered the local disinfectant treatment of diphtheria. P. 160, T. 40.6°.

February 7th (A.M.). Had a very restless night. Infiltration of the glands and cellular tissue of both sides of neck. P. 164, T. 40.4°. In the evening was a little better. P. 158, T. 39.8°.

February 8th (A.M.). Very restless night; now somnolent; jactitation; infiltration on right less. P. 160.

February 9th (A.M.). Patient somnolent; lies with head extended and has stertorous breathing; diphtheria has spread over fauces, notwithstanding repeated application of chlorate of potass. P. 160, T. 40.1°. In the evening the general state is better; the infiltration on the right is on the increase, on the left is stationary. Ordered, infusion of sennæ co., and warm bath at 35° C. of ten minutes' duration. Before the bath, P. 158, T. 39.7°. After the bath, T. 39.3°.

February 7th (A.M.). Slept quietly a number of hours after the bath. Restless after this; looks better; craves food; local condition the same. P. 160, T. 39.5°.

February 11th (P.M.). Purulent coryza, P. 160, T. 39.6°.

February 12th (A.M.). Right side otorrhœa; diphtheritic process is again extending, notwithstanding local treatment. P. 162, T. 39.4°.

February 13th (P.M.). Desquamation is beginning on throat. P. 136, T. 39.1°.

February 14th (A.M.). Desquamation on back. The infiltration of cellular tissue extends on right side as far as the clavicle. P. 144, T. 38.8°.

February 15th (A.M.). Had a very restless night; desquamation has set in on the legs. P. 148, T. 39.3°. In the even-

ing general state is much worse; locally the condition is the same. P. 172, T. 40.5°.

February 16th (A.M.). Desquamation quite general. The infiltration on the right side is to-day at one spot softer and the skin is reddened over this. P. 160, T. 40.25°.

February 17th (A.M.). Had a very restless night. Fluctuation over right side is more marked. Slight albuminuria. P. 162, T. 40.2°. In the evening, incision of the abscess on right side gave exit to a large amount of pus. P. 162, T. 40.8°.

February 18th (A.M.). Again a restless night. New scarlet eruption on face, arms and legs, in part discrete, in part confluent, here and there sharply raised above the skin. The portions of the fauces seen by the eye are free from diphtheritic deposit. P. 130, T. 39.4°.

February 19th (A.M.). Eruption disappearing from the lower extremities, but developing more markedly on the arms. Laudable pus is flowing from incision on right side. P. 140, T. 39.3°.

February 20th (A.M.). Restless night; respiration painful; collapse; imperceptible pulse; infiltration of both sides has conjoined in centre and has extended into right cheek. Fine diphtheritic exudation on mucous membrane of right side. Eruption has disappeared. Left pupil dilated. T. 39.6°

Toward noon the child died.

Aside from the typical picture which this case offers of infection complicated by phlegmon of the neck, it is of peculiar interest owing to the recurrence of the eruption on the 16th to 18th day with all the characteristics to which Thomas has given the name of anomalous eruption. The elevation of temperature and the restless night which accompanied the new eruption, was followed on the next morning by a fall of 1.4° C. This coincides with Thomas' observations, whose articles on measles, scarlet fever and rötheln in my "Hand-book of Special Pathology and Therapy" I take this opportunity of recommending to you highly as the best; I desire only to state that I do not consider Thomas' term "pseudo-recurrent" as a fortunate one, since this suggests that we are not dealing with a true recurrence. And yet it is really a true recurrence. We must look upon it, even as in typhoid, as an auto-infection from a source present in the organism, from which frequently enough the local disturbances arise and from which too must be traced

the acute kidney affection. To make it analogous to what happens in typhoid, since between the two infections there is no afebrile period, we must speak of the second eruption as a recurrence.

This case is further noteworthy from the prolongation of life notwithstanding the severe local and general infection. Of course the care and good nourishment given the child, as also the early local treatment of the throat, had much to do with this.

That the extensive local infection of the glands and the cellular tissue of the neck was due to diphtheria is proved by the fact that the abscess was dependent on the recurrence of the local diphtheritic process. At the end of life, especially, the infiltration in the right cheek presented unquestionable evidence of diphtheria.

I will further report to you a case of fatal scarlatina with secondary septic infection, this being completely proved at the autopsy.

Anton G., æt. 2¼, a weak child, reared amid great poverty, complained during the night of September 7th of sore throat, was feverish during the 8th, and on the 9th the scarlet eruption was present on the neck and back, there was great angina, with diphtheritic patches on the tonsils, and the general disturbances were severe. Examination of the urine was negative. Disinfection of the throat was at once resorted to. P. 144, T. 40.3°. In the evening of the same day he was somnolent, jactitation was present and great restlessness. T. 40.6°.

September 10th (A.M.). Had slept but one hour during the night; the eruption was spreading. P. 136, T. 39.6°.

September 11th (A.M.). The eruption was well developed, high colored, the angina unaltered. P. 144, T. 39.3°.

September 12th (A.M.). Was comatose during the night; great swelling of the angular glands, pulse very frequent and small. T. 40°.

September 13th (A.M.). General state worse. Exudation in pharynx; deep loss of substance on tonsils; no albumin in urine. T. 39.8°.

September 14th (A.M.). Much worse; somnolent; glands hard and swollen; no control over bladder. T. 40.8°.

September 15th (A.M.). The subcutaneous and intermuscular tissue of neck was infiltrated; the right wrist was swollen, very painful on motion and reddened. T. 40.1°.

The same general and local conditions obtained up to September 17th, when coma set in. T. 40.7°.

Death occurred at noon on the 18th of September.

Autopsy, September 19th: Diphtheria of soft palate; right tonsil infiltrated with pus; the left tonsil breaking down; purulent infiltration of the cellular tissue of the neck and of the glands of the neck, varying from simple swelling to purulent softening. Œdema of the lungs; abscess of the spleen; fatty liver; swelling of the mesenteric glands and of the solitary intestinal follicles; peri-articular abscess of right wrist.

The general septic infection, which was evidenced locally by the abscess in the spleen and the peri-articular abscess of the wrist, resulted in this case unquestionably from the diphtheria and the purulent softening of the tonsils. In other cases the septicæmia developed only after the breaking down of the infectious abscess in the cellular tissue of the neck. I have repeatedly seen such cases and will here briefly relate one to you.

Marie W., æt. 2¾, a strong child, was taken sick November 23d with the prodromal symptoms of scarlet fever, the eruption appeared the same evening, and on the 26th the glands began to swell. On the 28th she had intense angina and glandular swelling. The respiration became difficult and stertorous, on the 29th there developed great infiltration of the cellular tissue of the neck. On Dec. 1st great dyspnœa existed, owing to the narrowing of the isthmus faucium and diphtheritic obstruction of the nose. The temperature ranged from November 24th to December 1st from 39.8° to 40.8° C.

On December 2d after quite a restful night the temperature sank to 38.6° and the child was much better. On the 7th of December the child was out of bed for a few hours. The phlegmons, however, increased on both sides and were opened, leaving great defects in the substance, so that on the right the carotid was evident. Under careful local and general treatment the cavities filled in, and on December 17th the child was apparently well. On December 18th she had a chill, followed by high temperature, and the cavities began to suppurate again. The chill was repeated, the high temperature remained constant, and the child died on December 23d, the 30th day of the disease and the 5th of the septic pyæmia.

Fortunately such late septic pyæmia is a rarity as well as

fatal hemorrhage from eroded vessels within the suppurating cavities—I have seen one instance of fatal hemorrhage from a branch of the carotid;—ordinarily the abscesses tend, after separation of the slough and disappearance of the fever, to heal by granulation.

The extension of the infectious inflammatory process into the naso-pharynx and into the nostrils, as also along the Eustachian tube into the middle ear, are not in themselves processes dangerous to life, although they are severe affections and unpleasant enough in their consequences, especially bilateral otitis media, perforation of the drum and lasting deafness.

In addition to the complications we have spoken of, in severe epidemics others may be met with, which I will only mention here, seeing that they are rarities: Diphtheria of the pharynx, œdema of the glottis, meningitis, endocarditis, pericarditis, decubitus, etc. Owing to the manifold accompanying phenomena which the scarlatinal poison may evoke in the organism, the disease may approximate typhoid and cholera. It simulates the latter in that the poison works very quickly in the development of deleterious effects, although in gravity and in mortality rate it does not reach the degree of cholera.

In frequency of occurrence and in gravity, scarlatinal nephritis, the careful recognition of which is essential, comes after diphtheria and malignant angina. The insidious beginning of this affection may lead the careless physician into fatal error.

As to the cause of scarlatinal nephritis, it is no longer looked upon as due to a cooling of the skin which is sensitive from the desquamation process, or as a consequence of the shedding of the epidermis which should subserve the purpose of protecting the glands of the skin. We rather with justice look upon the inflammation of the kidneys as the result of the localization and irritation of the parenchyma by the scarlatinal poison and that according to the amount and the virulence of the poison there result the higher or lesser grades of disturbances of the renal function.

These disturbances usually consist in dropsy and in changes in the urine. During the course of the 2d or 3d week when the desquamatory process is nearing its end it will be sud-

denly noticed that the child looks pale and puffy. Frequently repeated vomiting will cause the physician to be sent for, and he will at once examine the urine. The anasarca can rapidly spread and attain enormous dimensions, greater indeed than in other forms of dropsy; it is quickly complicated by hydrops of the serous membranes; the peritoneum, pleura, and pericardium being usually affected.

The changes in the urine are in general those of acute hemorrhagic nephritis. The amount of urine is greatly diminished, the urine is concentrated, dark, cloudy, containing blood, and is very rich in albumin, casts, and epithelial cells.

After about eight days the albumin and blood diminish and the amount of urine increases, although there is no return to the normal. In these mild cases the nephritis lasts from two to three weeks and ends with rare exceptions in recovery.

Severe cases, on the other hand, run their course with far more stormy symptoms at the outset, and the patient's life is seriously threatened. The gravity of the affection is at once recognized by the acute onset with chill, high temperature, frequent vomiting, pain in the lumbar regions, oliguria of a high grade, even complete anuria. If the urinary secretion is not influenced at once, only a small amount of very bloody urine may be passed for many days, becoming solid on heat, and then the risk of uræmia presents itself. Frequently uræmia sets in at once; vomiting, headache, coma, convulsions, amaurosis develop in a few hours, and death may follow in a very short time. It is difficult to give a prognosis, because the most severe cases of uræmia unexpectedly may improve rapidly, as I have repeatedly witnessed, while seemingly harmless kinds of nephritis may end in death from repeated attacks of convulsions. We must therefore be very careful in our prognosis, and hope should not be lost even in the severest cases.

In many instances the insidious course of the kidney disturbances renders the secondary dropsy dangerous; wound infection may set in through erysipelas or abscess of the tears in the greatly stretched skin, or else the mechanical effects of dropsy of the serous cavities, especially ascites and hydrothorax may lead to death. In 1850, when it was not the custom to puncture in case of pleural exudate and transudates, I lost a number of children from these sub-inflammatory dropsies of the pleura and the pericardium.

The following case will serve as a type of severe scarlatinal nephritis.

Anna G., æt. 6, a badly-nourished, scrofulous child, with evidence of antecedent rachitis, after a prodromal period of two days with high fever had the eruption. On the 5th day, diphtheria, purulent coryza, and bilateral swelling of the angular glands appeared. After the 7th day the fever subsided, and all the local processes improved. On the 14th day desquamation set in, which on the following day had spread over the body. The temperature became normal and the child improved in every respect.

On the 18th day œdema first appeared on the face, the temperature rising a little toward evening, the urine being diminished, cloudy, containing a considerable amount of albumin. The following day the child vomited a number of times; the temperature increased, as also the dropsy, which implicated the pleura and peritoneum. The temperature rose to 39.7° in the evening with a morning remission to 38.5°. The glands of the neck were still swollen.

The urine remained scanty for the next few days, contained much albumin and granular casts and blood in great amount.

The hydrothorax and dyspnœa increased the respiration up to 60. The heart remained strong. Warm baths followed by packing were ordered.

Up to the 26th day the orthopnœa and severe general disturbances lasted; the temperature was lower, the amount of urine constant, the pulse smaller and more frequent, up to 156; the dropsy, especially the hydrothorax, increased; there was aggravated bronchitis. On the 28th day the child died.

At the autopsy there was found general dropsy, especially of the serous cavities, double catarrhal pneumonia, collapse and compression of the lungs, bronchial catarrh, swelling of the bronchial and neck glands, one of the latter being purulent. There were small abscesses in the left tonsil. The right ventricle of the heart was dilated, the muscle of the organ being generally pale. The liver was a trifle enlarged, the spleen normal. Of the kidneys, the left was quite enlarged, 3.3 inches long, 1.4 inches broad, 1.5 inches thick. The capsule was somewhat adherent, the surface smooth, pale gray in color, here and there injected. The cortex was .15 to .19 inch thick, pale gray and sharply differentiated from the red pyra-

mids. The right kidney was similar to the left in size and appearance. There were also present intestinal catarrh, and slight œdema of the brain substance.

We pass now to the treatment of scarlet fever, a subject the difficulty of which every experienced physician recognizes. As to the result of treatment and as to the mortality rate in different epidemics, I desire to emphasize the fact that in scarlet fever even as in other pandemic infectious diseases the efforts of the physician are most important. Remember, gentlemen, that the physician can accomplish much and save many lives which would be lost were not great care exercised. Of course much work is thereby required from the physician and the attendants.

Let us begin with the treatment of the fever and the other symptoms of general infection. We possess no means of preventing the development of the infectious germs or of paralyzing the effects of their poisonous products. It remains for us then to maintain, as far as is possible, the resistance capability of the organism and the energy of the nervous system. In the first rank stands hydrotherapy, especially in the form of cold and of lukewarm baths and spongings. Currie, the discoverer of the value of hydrotherapy in the infectious diseases, has carefully laid down the indications in scarlet fever. "My method," he says, "when I am called early to the patient, is to unclothe him and to pour four to five gallons of water, as cold as we may, over him. This has the desired cooling effect, although it is not as lasting as in typhoid. After two to three hours the temperature is not exceptionally found as elevated as before. The cold baths must therefore be repeated as often as the increase in temperature demands; occasionally it is necessary to resort to them ten to twelve times in the twenty-four hours. The height of the fever is thus broken and lukewarm baths at infrequent intervals are sufficient to control the disease. During this period the drink should consist of cold water and lemonade, and movements of the bowels should, when requisite, be obtained by calomel. . . . Marked restfulness and desire for quiet and sleep follow on this quick control of the fever, and occasionally to such a degree as to make us fear coma or a too-marked sinking of the vital forces; but I believe that this fear is unfounded. It is always advisable, however, to keep the surface and the extremities warm,

and to leave the patient in the quietude which nature demands. . . . When, however, the anxiety of the parents or the care of another physician bind our hands and this method cannot be resorted to, then we must resort to lukewarm baths, which are less effective. Only to a degree will these control the disease, by rendering it milder, since they lower the heat and cause perspiration."

Currie, after testing this method for thirty-nine years, had the opportunity to apply it during the very malignant epidemic at Liverpool in 1881. He treated over 150 children, including his own, and was satisfied of the value of the method. He calls attention to the fact, however, that the cold full bath is contra-indicated in adynamic states of the patient, and that here it is better to use the lukewarm, or even the warm bath.

It is not necessary to add anything to the results of this careful observer. The correctness of his observations and conclusions has been proved by numbers of English physicians who tested them in the severe epidemics which occurred in the beginning of this century. In recent times, also, has the great value of hydrotherapy in the treatment of scarlet fever been noted. The extent of the water treatment must, of course, be measured by the physician in the individual case; the earlier the patient comes under treatment, the higher the body heat, and the more resistant the organism, the lower should be the temperature of the bath. On the third and fourth day, on the other hand, and in adynamic cases only lukewarm or warm baths should be resorted to, and stimulants should be administered to tone up the nervous system. It is advisable, gentlemen, in such adynamic cases of scarlet fever not to resort to cold sprinklings but only to the full bath, and to order this gradually cooled, as I taught you in speaking of the treatment of typhoid fever. When you place a patient with a temperature of 41° C. into a bath of 35° C. and you cool the bath by the addition of cold water, then after the bath you can estimate the effect on the organism better than if you had resorted to greater cold at once. The action, as I pointed out when speaking of the treatment of typhoid, is not alone to cool the blood, but the thermic irritation reacts centripetally and refreshes the central innervation, and in consequence the functions of the organs essential to life.

The action of antipyretic drugs, in particular antifebrin and antipyrin, cannot be gainsaid, but they cannot take the place of hydrotherapy, since without this the refreshening of the nervous system is lacking. It is preferable to administer these antipyretics per anum owing to the dysphagia.

Of particular value in aggravated cases is the local treatment of the diphtheritic affection of the throat and the infectious infiltration of the angular glands and of the cellular tissue of the neck. From my experience I cannot agree with those writers who abhor energetic cleansing and disinfection of the throat and only resort to inhalations and to gargles. I find that the cleansing of the diphtheritic mucous membrane of the throat by means of disinfected charpie rolled on sticks followed by application of carbolic solutions (1:2 to 1:10) if resorted to early have a beneficial effect. Such energetic disinfection is only required once to twice weekly, while the spraying and gargling with boric acid and chlorate of potass solutions must be resorted to daily.

The earlier the disinfection of the throat the less likely the extension of the local infection to the tonsils, the lymph glands, and the subcutaneous and inter-muscular cellular tissue. The specific infectious process seems further to lead in the tonsils very quickly to suppuration and thence to the formation of a readily absorbable and very infectious material. The abscess lying in the depth of the tonsil cannot be reached by our present means of disinfection, and hence it is clear why in many cases, notwithstanding all possible local treatment and disinfection, we cannot prevent infection of the lymphatic glands and of the cellular tissue. The parenchymatous injection of carbolic acid into the tonsils and soft palate, recommended by Traube, Götz, and Heubner, would seem to overcome this difficulty. I have not as yet had the opportunity to test the method, but I deem it very rational to bring the antiseptic fluid directly into the source of the vessels which lead to the lymph glands, and the method, according to the latest reports from Heubner ("On Scarlet Fever Diphtheria and its Treatment," Volkmann's "Sammlung Klinischer Vorträge," 1880, No. 32), is as simple as it is therapeutically effective.

The method consists in filling a long syringe with three to five per cent carbolic acid, plunging the needle into the tissue of the tonsils and soft palate and injecting two to three times

daily a half of a Pravaz syringe-full. Indications for the beginning of this local treatment Heubner states to be rising fever and swelling of the lymph glands on the 3d to 5th day, and the decline in these symptoms is the indication for cessation of the treatment.

The treatment of the tumors of the lymph glands and of the infiltration of the cellular tissue of the neck is not a definite one. Local venesection is not useful, indeed is often bad. Ice-bags around the neck are at least good for their subjective effect, as also poultices, which diminish the pain and tension. But suppuration of the infiltration you can neither prevent nor modify. In case a softened spot is determinable, incision with antiseptic precautions should at once be resorted to.

The coryza and otitis media call for careful treatment. Irrigation of the nose with Weber's nasal douche, the head being bent forward, is very useful, since thus not only are the nostrils but also the naso-pharynx irrigated. It will suffice if you will irrigate five to six times daily with warm lime water or boric acid solution. As regards the otitis media, the point is to determine the right time for puncturing the drum, that is to say, neither to operate too late nor to allow spontaneous perforation. Many individuals might be spared difficult hearing for their whole life if the drum had been perforated at the right time in case of otitis media complicating scarlet fever and if afterward the ear affection had been subjected to careful antiseptic treatment.

The treatment of scarlatinal nephritis allows in general of more precise statement and indications. It must be granted at the outset that an organ in a state of inflammation must not be spurred to action. The disturbances in secretion are the result of inflammation, and it must be laid down as a law, therefore, that so long as the inflammation, the disturbance of secretion is present to a high degree, the functions of the organ should be spared as much as possible. We are able to cause a vicarious organ, the skin, to functionate to a high degree, and thus not alone may the water of the urinary secretion be excreted but also a portion of the solids.

Of the different diaphoretic methods the hot bath followed by wrapping in woollen cloths recommends itself as the best for severe cases of nephritis, while the vapor bath, which is highly to be commended, is preferable for milder cases where

the patient is able to sit exposed to the vapor. The hot or the gradually heated bath I have tested for many years and have recommended highly in the treatment of scarlatinal dropsy. ("Die Methodische Behandlung des Hydrops." "Deutsch. Arch. f. Klin. Med.," II., 1867.) The method consists, after Liebermeister, in gradually adding hot water to the bath up to 38° C. to 41° or 42° C., followed by wrapping in wool. The duration of the bath should be from one-half to one hour, and the wrapping during the profuse perspiration period from one to two hours. This diaphoretic method of Liebermeister, after twenty years' test and experience, I must consider the best for the treatment of all forms of renal dropsy, especially for patients who cannot sit well but can only recline. In case of chronic nephritis the vapor bath, which we have used for years in the Munich hospital for purposes of diaphoresis, is the simplest and best, and as applicable in private as in hospital practice.

I would note further, gentlemen, that the hot bath given once a day, for the first one to two days does not often cause special diaphoresis, but that on the third day the perspiration is profuse. I give an example.

Heinrich Glas, æt. 2½, strong and well-nourished child, had mild scarlet fever on May 11th, with temperature not over 40° C., the eruption being somewhat irregular, and on the 8th day the fever had disappeared. On the 11th the desquamation was about at an end. June 1st he vomited a number of times, œdema of the face appeared, and during the following days œdema of the lower extremities and ascites set in.

June 4th he was sent to the Erlangen hospital. He was very anæmic and somnolent. There existed very great dropsy of all the extremities and of the face, abdomen, and back; great ascites, bilateral hydrothorax; considerable hydropericarditis, systolic murmur over the whole cardiac region with increased second pulmonary sound. The spleen was enlarged; the urinary secretion reduced, reaction alkaline, much albumin and blood. Microscopically there were blood-corpuscles, epithelial and fibrinous cylinders, triple phosphates and calcium phosphate. The body weight was twenty-nine pounds. The temperature was 39.8°, and patient was ordered infus. digital., and a hot bath raised to 39° or 40.5° daily, and afterward wrapping in wool.

The perspiration following the baths diminished the anasarca greatly. During the first few days the boy could not be weighed owing to his low state, but on June 6th (P.M.) after three baths, he had lost three pounds. The dropsy had not only markedly lessened in the extremities, but the level of the ascites and of the hydrothorax had lessened about 1". The quantity of urine had altered but little, the quality was the same. The fever had fallen, but the pulse was still frequent, the anæmia, appetite, and somnolence were unchanged. Daily 1½ grains of benzoic acid were given him.

On June 7th he was still very restless. Had a yellow stool mixed with blood. The urine was clearer and more profuse. The quantity could not be measured, since much was lost in bed and at stool. The appetite was good. Before the bath and wrapping (the fourth) his weight was 25¾ pounds, the pulse 116, the respiration 56, the temperature 38.25°. After the bath: weight 25¼ pounds, pulse 125, respiration 48, temperature 38.55°.

June 8th. Patient coughed much during the day and night, the cough being paroxysmal. The hydrothorax was slight, the hydrocardium had disappeared, the systolic souffle was still to be heard, the anasarca was less, the urine was scanty, alkaline, containing much albumin, but little blood.

Before the fifth bath and packing: weight 25 pounds, temperature 37.85°. After the bath: weight 24½, temperature 38.16°.

Patient was ordered the liq. ferri iodati.

June 9th. The cough was worse; râles over the lungs, systolic souffle weaker, slight systolic fremissement over cardiac apex. Urine scanty. Before the sixth bath: weight 25½ pounds, pulse 120, respiration 52, temperature 38.55°. After the bath: weight 25¼ pounds, pulse 124, respiration 48, temperature 38.65°.

June 10th. Had slept well during the night. Patient has better appetite. The stools are formed. Before seventh bath: weight 26, pulse 100, temperature 38.15°. After the bath: weight 25¾, pulse 104, temperature 38.85°.

June 11th. The patient had not perspired more than usual after the last bath, but for the first time he remained moist after the wrapping. The dropsy has been generally reduced. The baths were, therefore, discontinued. P. 112, R. 48, T. 38.25°.

June 12th. The general condition good; the quantity of

urine increased; spontaneous perspiration during the night. A.M.: P. 120, R. 44, T. 37.45°; P.M.: P. 100, R. 48, T. 37.65°.

June 13th. Had a restful night. Still has considerable bronchial catarrh; passes urine in greater amount, since last night 12½ ounces, sp. gr. 1010, albumin slight. The ascites very slight; anasarca gone, weight 23¾ pounds. A.M.: P. 108, R. 48, T. 38.55°; P.M.: P. 112, R. 48, T. 37.85°. Ordered the iodide of iron again; beer instead of wine; meat in large quantity.

June 14th. General condition good; anæmia diminished; only traces of ascites and hydrothorax; anasarca has disappeared. The urine is dark, concentrated, alkaline, contains but little albumin. Weight 22¾ pounds. P. 120, R. 48, T. 37.75°. In the evening spent a number of hours out of bed.

From June 15th patient was out of bed. Appetite and bowels in good order. Still has slight evening rise of temperature. The urine is clearer and contains less albumin. Weight varied from 22½ to 23½ pounds.

June 23d. Souffle had disappeared; only a trace of albumin in urine. Is still very anæmic. Carbonate of iron was ordered.

June 23d to 30th. Weight increased to 24 pounds. No albumin nor dropsy.

July 1st. Evening rise of temperature and a colitis developed which quickly pulled the patient down. Albumin reappeared in the urine and patient again became œdematous. By the end of July the patient was much better, and on August 4th he was discharged and has remained well.

Every case does not run its course so favorably. Nephritis associated with anuria is very dangerous and calls for other treatment in addition to the baths in order to prevent the development of uræmia or to control it if present. Above all other agents pilocarpine is here useful, as also champagne and alkalies. The latter are best administered in milk. Milk in large quantities is a very valuable dietetic and therapeutic agent in scarlatinal nephritis. Digitalis is a valuable drug, and to this may be added the liquor ammonii or potass. acetatis. Where uræmia does not threaten, it is best to withhold all medication.

It goes without saying that every care must be taken during convalescence, even though all disturbance of the kidney, above all albuminuria, has ceased. In particular must any-

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thing which might irritate the kidneys be avoided, such as alcohol, catching cold, etc. The wearing of woollen underclothing and, when possible, residence in a warmer climate during the inclement season are to be recommended.

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PATHOLOGY AND TREATMENT OF RINGWORM.

CHAPTER I.

THE FUNGUS.

THE diseases now known as Ringworm of the Scalp (Tinea tonsurans) and Ringworm of the Body (Tinea circinata) had been long recognized before it was suspected that they were caused by a fungus.

The honor of discovering the fungus (Trichophyton tonsurans) is shared by Gruby, in France, and by a Swede, Malmsten; the former having announced the discovery in 1844, and the latter in 1845.

It is my present purpose to describe, so far as is known, the nature and peculiarities of this fungus, the changes in the human skin to which it gives rise, and the treatment which experience shows is most likely to be successful in destroying the parasite and curing the diseases which it causes.

The structure of the fungus is that of a tube. The walls of this tube are formed of a delicate sheath, the contents consisting of a protoplasm, which in the process of development becomes transversely divided by septa.

Within the septa rounded spores are formed (so-called conidia). In the further course of development, the sheath gives way, the spores are set free, and each spore becomes capable of development into a fresh mycelium or tube.

The tubes may be found solitary or in parallel lines, or bifurcating and giving off branches from the parent stem indefinitely, according as the nature of the soil in which they grow causes compression or favors free extension in several direc-

tions. But the process is always essentially the same. A spore, under conditions favorable to its growth, shows first a more marked differentiation between the wall and its contents; the cell-wall then bulges at one point, the protoplasm follows, and the rounded spore has become a pear-shaped body. The projection increases until we have a short tube, at one end of which the rounded remains of the spore can still be detected.

Finally, as the tube lengthens the remains of the spore disappear, septa begin to form, and new spores are formed. This is the whole cycle of the development of Trichophyton tonsurans.

The fungus being a minute object, its structure can only be seen by using a microscope, a power of from 250 to 500 diameters being very suitable for the observation.

There is absolutely nothing in the appearance of the spores or mycelium to distinguish them from those of many other microscopic fungi, known and unknown; a fact that has led to errors of observation which have been copied and handed down from one book to another until they have become classic.

We only know that we are dealing with Trichophyton tonsurans when we find it associated with the disease that it causes, or when we find that the fungus we are studying fulfils the characteristic conditions of growth in artificial cultivation.

Trichophyton tonsurans grows on the skin of man, the horse, cow, dog, cat, mouse, and rabbit, and it can be communicated by contact from any one of these animals to the other. Its most frequent seat is the hairy scalp of young persons of both sexes under the age of puberty. Probably next in frequency comes the skin of the horse; and after the horse that of the dog and the cow. In man certain conditions peculiar to the individual or climate, or both combined, render the skin favorably predisposed to its development. But there seems little doubt that the most favorable soil for its growth is the scalp of children, the anatomical conditions of which are specially favorable both to the protection and the observation of the fungus.

The perusal of even recent works on diseases of the skin would not lead the reader to believe that Trichophyton tonsurans is a specific fungus which is only to be found in the skin of certain animals. Indeed authors of the highest authority

have expressed a contrary opinion. Hebra and Neumann have stated that the fungus is identical with Penicillium glaucum (for an easy method of demonstrating that Trichophyton tonsurans is not Penicillium see "Addition to a former paper on Trichophyton Tonsurans," Proc. Roy. Soc., No. 241, 1885); while Lowe, in 1850, was led to believe by his experiments that Trichophyton tonsurans is a spore-formation of Aspergillus, and Dr. Atkinson believed that he had shown that the fungus belongs to the Mucors and is probably Mucor mucedo.

These errors are reproduced in the most recent works. They are errors due to foul cultivations, the difficulty of securing and maintaining a pure cultivation of the fungus having been until quite recently very great.

The maintenance of purity in cultivations is hardly attainable except by the more exact new methods which have been lately introduced by experts in the study of lower organisms. The beginner in this department of study, probably a dermatologist without special training, who is led to take up the subject by his interest in the disease, is apt to find at the end of his first month's work that he has developed his original stock of Trichophyton tonsurans into one or more of the varieties of the common fungi. If he doubts his results sufficiently to continue his work he will probably come to recognize that he has long lost his original stock and has been cultivating the fungi whose spores are omnipresent in the atmosphere in which he works.

If hairs from the head of a perfectly healthy person are cultivated in any ordinary media, unless special precautions are taken and carried out by the skill of the expert, many of the hairs will be found to have their roots enveloped in a thick mesh of fungus, which, microscopically, it is hard, and perhaps impossible, to distinguish from Trichophyton tonsurans. A distinction, however, is to be made by crucial cultivations. The Penicillium, Aspergillus, Mucor, etc., which observers have found in their cultivations, did not come from Trichophyton tonsurans, but their spores fell into the media of cultivation from the air or were introduced into them by the instruments employed.

A consideration of a well-known fact ought to have prevented the acceptance of the theory that Trichophyton tonsu-

rans is one of the common fungi. Let regard be had to the facility with which the fungus develops in the heads of children. In many cases it suffices for a child to wear for a very short time the cap of another child who has ringworm to insure the transmission of the fungus to the new soil. But the caps of all children, as a matter of fact, contain on their exposed surfaces multitudes of spores of all the common fungi, and ringworm does not result if these caps be worn.

In villages into which the disease has not been introduced or in which it has become extinct, numbers of children have their hair and their caps constantly exposed to the atmosphere for years without a single case of ringworm resulting. Yet the atmosphere is loaded with spores of common fungi.

Among the erroneous ideas that have originated in the attempted cultivations of parasitic fungi by imperfect methods is the suggestion that these fungi can be developed into each other. There is no doubt that this hypothesis is based on errors of observation, and that the question which has been raised as to the identity of Trichophyton tonsurans with the fungi of Favus and Tinea versicolor must be answered in the negative.

Microscopically these three fungi can be distinguished from each other, and they do not behave in the same way under attempted cultivation.

I have never found Trichophyton tonsurans transformed by cultivation into either of these fungi, and I have made many unsuccessful attempts to cultivate the fungus of Tinea versicolor in media in which Trichophyton tonsurans grows freely. I have made a few attempts to cultivate the fungus of Favus in similar media and also failed.

Although this book is intended to be chiefly of an expository and practical character, it may be useful and interesting if I make a few remarks regarding the methods of cultivating Trichophyton tonsurans.

And first a preliminary remark. Let no enthusiastic worker begin with the study of this or any other fungus. The isolation and cultivation of fungi and micro-organisms is an art which can only be acquired by practice. The experimenter must first satisfy himself that he can render and keep pure, for at least six weeks, milk, beef-juice, urine, and meat-gelatin, and when he has succeeded in doing this he may begin to

work. Until he has acquired the requisite skill to keep these media pure his observations will be worthless.

The range of media suitable for the growth of Trichophyton tonsurans is not yet defined. I have reason to believe that several workers are in possession of facts, still unpublished, which show that it is wider than I have found it to be in my experience. So far as my own experiments go, I found that it was possible to grow Penicillium, Aspergillus, and other fungi on media in which Trichophyton tonsurans was sterile.[1]

The ringworm fungus grows freely for a time in aqueous humor, vitreous humor, and the meat-gelatin introduced by Koch.

Aqueous Humor Cultivations.—Take a slide which has a cell and purify it by heat. Purify a cover-glass by passing it through a flame. As soon as it has cooled place a drop of freshly extracted aqueous humor on its centre, using pure instruments. Then insert in the drop a freshly extracted ringworm stump, placing it close to the cover-glass. Invert the cover-glass over the cell, and prevent evaporation by passing a fine brush dipped in oil round the border. Place the slide in an incubator kept at a temperature of 96° to 98° Fahr. Within forty-eight hours the spores in the hair will be found to have projected in the form of short mycelia from the edge of the hair. The growth, however, will not advance far on account of the deficiency of fluid, and its rapid decomposition by bacteria, which have been introduced with the hair.

Vitreous humor is a more convenient medium of cultivation than aqueous humor, on account of the facility for obtaining it in quantity; it was with vitreous humor cultivations that the special character of the fungus was first established. The method which I found suitable was the following: Having collected a number of fresh ox eyes, I cut the ball transversely with a sharp knife, and removed the vitreous humor. When I had collected a sufficient quantity, taking care to keep it free from pigment, it was passed through fine muslin, and was rendered pure by being placed for a sufficient time in a pure flask, immersed in boiling water. When purified it was decanted with proper precautions into pure glasses. The details of the methods for securing and maintaining purity are those devised by Lister, and explained in his paper

on "Lactic Fermentation" in the twenty-ninth volume of the "Transactions of the Pathological Society of London."

The precision and exactitude obtainable by Lister's apparatus and methods are perfect, although the introduction of solid media by Koch (in combinations of gelatin) enables us,

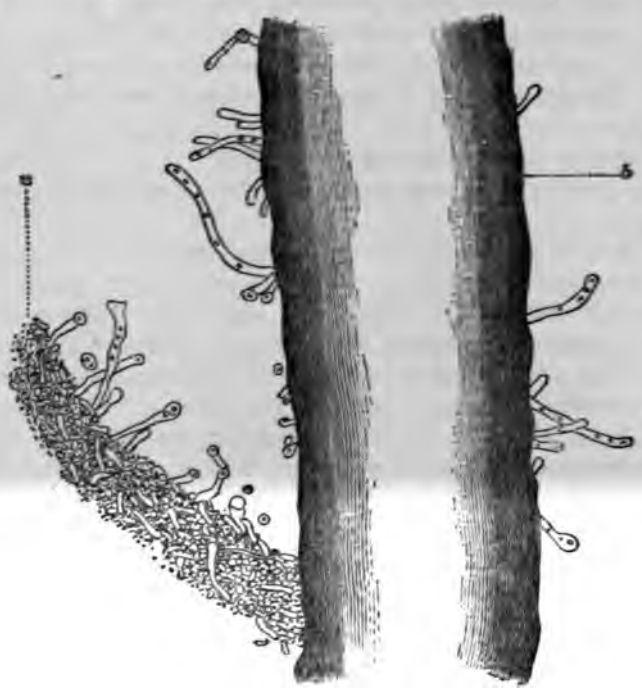

FIG. 1.—A Hair from a Cultivation on the Surface of Vitreous Humor in a Test-glass. A mass of germinating and sprouting spores on a portion of the internal root-sheath which was attached to the hair is seen at the side of the hair shaft. Buds and mycelium are sprouting from the sides of the hair. (In order to reduce the size of the drawing the centre of the hair-shaft has been left out. No attempt has been made to represent the fungus growth on the upper surface of the hair, as it lies in the preparation. The outlines were too much obscured by the thickness of the hair to enable this to be accurately done with the camera): *a*, the appearance of the inner root-sheath of the hair—the spores which were lying on it are in free development; *b*, the hair-shaft. Magnified 450 diameters.

in most cases, to dispense with the more difficult task of working with liquids. The necessity in certain cases of cultivating in liquids has not been superseded, and when they are used Lister's methods will, I believe, be found more reliable than any other yet discovered.

In cultivating Trichophyton on vitreous humor, the liquid

is decanted into a pure glass and the ringworm hair is laid on its surface.

The glass, properly covered to prevent rapid evaporation, is placed in an incubator. Within forty-eight hours mycelia will be found growing freely from the affected part of the hair. Numerous spores will be found on the slide which has been prepared for microscopical examination, lying near the hair and showing all stages of budding and development into mycelia. Growth continues for several days longer, but finally becomes checked. It is very rare that true septa form in the mycelium which is developed from the spores in vitreous humor. Usually a series of refractive particles which simu-

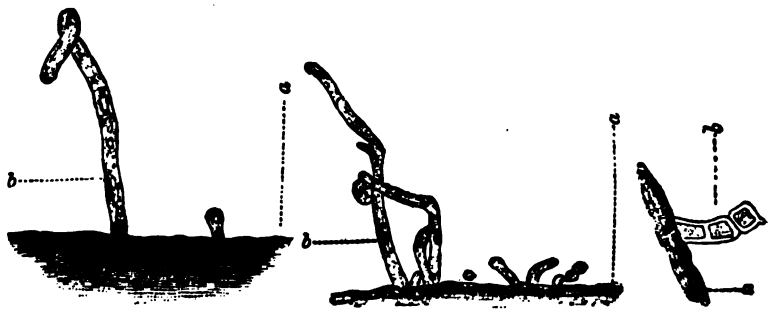

FIG. 2. FIG. 3. FIG. 4.

FIG. 2.—Mycelium Developed in Vitreous Humor Cultivation in a Cell two days in the Incubator. *a*, Edge of hair-shaft; *b*, mycelium. Magnified 750 diameters.

FIG. 3.—A Cultivation on the Surface of Vitreous Humor in a Test-glass. *a*, Edge of hair-shaft; *b*, mycelium which is beginning to throw off a branch. Magnified 600 diameters.

FIG. 4.—Two Days' Growth in a Cell. *a*, Edge of hair-shaft; *b*, Mycelium with true septa. Magnified 750 diameters.

late spores are found, but they are much smaller than true spores and do not appear to undergo development. The characteristic appearances seen are illustrated in Fig. 1.

Appearances such as those shown in Fig. 2 suggest that the refractive particles referred to have something to do with an attempt at formation of spores.

The mycelia growing free in the liquid occasionally show a characteristic tendency to branch, as is illustrated in Fig. 3.

Only once did I observe an appearance which I considered absolutely distinctive of regular spore-formation. It is shown in Fig. 4.[2]

In addition to the growth of Trichophyton will be found in these cultivations a growth of bacteria of well-defined forms:

micrococci, rod-shaped bacteria, and sometimes sarcinæ. It is evidently through the luxuriant growth of bacteria that the growth of Trichophyton becomes checked. As soon as the vitreous humor becomes decomposed, it ceases to be a fit soil for the fungus.

It is therefore advisable not to put many hairs in the glass, because the greater the number of hairs the quicker the decomposition of the liquid by bacterial growth. Among the bacteria that are found developing in such cultivations, it is sometimes observed that special forms are peculiar to certain individuals.

The hairs of some children give rise, for example, to a growth of sarcinæ, while those from other children show none. I once had occasion to observe that in hair cultivations from several children in one family, there was developed a short, thick, and very dark bacterium, almost black in color. On no other occasion have I observed a similar organism.

I have called special attention to the methods of vitreous-humor cultivation, because there are important problems connected with the life history of the fungus, and its behavior on the scalp, which I think are more likely to be solved by this method than by any other.

Meat-Gelatin Cultivations.—The least troublesome and most certain of all the methods of cultivating Trichophyton, is the use of the gelatin preparations introduced by Koch.

Tubes of purified meat-gelatin can be bought, and the methods of using them are described in works which are easy of reference.

Several slides, being purified by heat, are laid on a table, the surface of which has been made clean by carbolic or bichloride of mercury solutions. A purified glass dish or jar is placed over them to prevent contamination. The tube of neutral meat-gelatin is melted, the cotton plug removed, the edge of the tube passed through the flame of a spirit lamp, and the melted gelatin is emptied on the slides, care being taken that the quantity on each slide is not sufficient to reach the edges. The glass jar is replaced on the slides until the gelatin has become solid. Short ringworm hairs or stumps being extracted by forceps that have been previously purified by heat, are laid at intervals on the surface of the gelatin, into which they are lightly pressed by a purified needle.

A rounded glass dish, on the bottom of which is placed wet blotting-paper, receives a purified glass plate, and on this plate, slightly raised from the blotting-paper by glass rods, the slides are laid. The dish is then covered, the under-surface of the cover having been previously heated with the flame of a spirit-lamp to destroy any spores which were attached to it. The covered dish is then allowed to stand at ordinary room temperature (ordinary meat-gelatins become fluid at body temperature), but a dust-proof cupboard in a warm room is most convenient. The warmer the temperature (so long as the gelatin does not become fluid) the quicker is the growth of the fungus.

The earliest change observed in this as, indeed, in all other cultivations, is the optical separation of the spore into envelope and contents, the spore being somewhat swollen as compared with its size before cultivation was begun. This is

FIG. 5.—First Change Observed in Spores at the Commencement of Cultivation. *a*, Edge of hair-shaft; *b*, a cluster of spores in which the envelope and central point of the spore are differentiated.

illustrated in Fig. 5. It seems to depend on the absorption of fluid, because it is observed in spores attached to hairs when the hairs are soaked in fluid of any kind and when the cultivation remains perfectly sterile.

If one of the slides is examined under a microscope with a low power (fifty to eighty diameters) in two days, if the room has been warm, the spores which were situated on the borders of the hair, will be seen to have grown outward into the gelatin as short mycelia. This examination can be easily made without the use of a cover-glass, and the slide can be put back in the incubator for further development.

The oftener and the longer the slide is exposed to the air, the more numerous will become the colonies of Penicillium and other adventitious growths on the gelatin.

Under these conditions the mycelia continue to grow for some days longer. At the end of five days to a week the hair presents a somewhat beautiful appearance. An immense

number of mycelial threads have grown out like a brush from the shaft. If the hair selected is a stump from a head that has been treated for ringworm, the free part of the stump

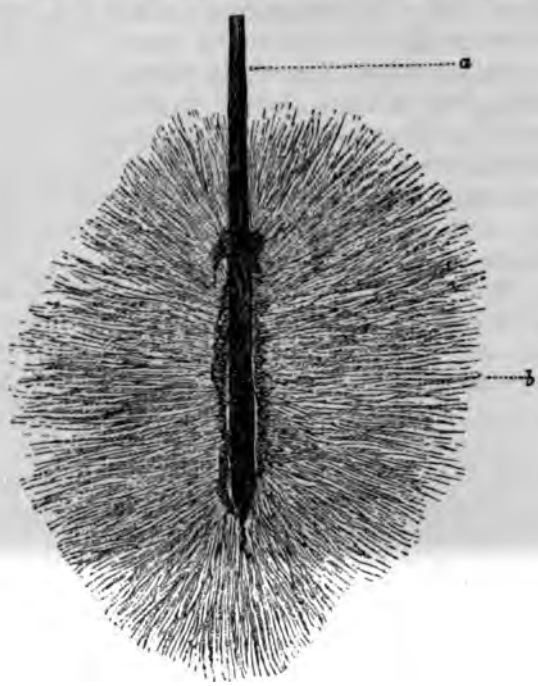

FIG. 6.—A Ringworm Stump (from a Case of Treated Ringworm) Cultivated on Gelatin for Six Days at Ordinary Room Temperature. *a*, Free surface of the hair-shaft; *b*, abundant growth of mycelia as seen under a low magnifying power.

remains sterile while round the root the growth is abundant. This appearance is illustrated in Fig. 6. Fig. 7 illustrates the

FIG. 7.—A Mycelium as seen under a High Power; from the same preparation as is drawn in Fig. 6.

appearance of the mycelium grown on gelatin as seen under a high power.

While in these gelatin cultivations the mycelial tubes lengthen and give out branches, the absence of a rapid and

true spore-formation betrays the fact that the fungus is not in its native soil. The rapid subdivision of the protoplasm by septa, which is the normal development of the fungus, does not take place in the gelatin cultivations, but as in the vitreous-humor cultivations there is a more or less successful attempt at this formation. In many cultivations septa or spore formations are not observed at all, but occasionally an unmistakable tendency to accumulation of the protoplasm in something like septa is very apparent. This appearance can be sometimes seen more or less distinctly if the preparation is stained by methylene blue. Figs. 8 and 9 from different preparations illustrate this appearance.

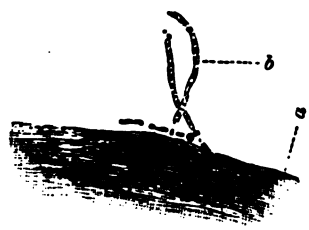

FIG. 8.

FIG. 9.

FIG. 8.—A Gelatin Preparation Stained in Methylene Blue. *a*, Edge of hair-shaft; *b*, mycelium in which the protoplasm has separated into clumps suggestive of an attempt at spore formation.

FIG. 9.—Mycelium from another Preparation, in which the same appearance was even more strongly marked.

Of course the separation of the protoplasm into clumps, even when fairly regular, does not necessarily imply the physiological act of formation of spores, although it is highly suggestive of it. It may, on the other hand, be a simple physical change in the protoplasm produced by its being in a non-natural medium.

These experiments show that Trichophyton tonsurans (which, as we have seen, is a fungus by itself and totally distinct from the common fungi whose spores infest all the objects by which we are surrounded) can be cultivated artificially in media derived from animal organisms or substances. Speaking metaphorically, it may be described as a carnivorous fungus. It is not only carnivorous in the general sense of the

word, but with the daintiness which characterizes so many low organisms, it only grows on certain structures or parts of the animal on which it lives.

The home of this fungus is in certain structures of the skin of some of the mammalia. We have no evidence that it lives and propagates in any other soil; and in the affected animals it is only in certain epidermic structures that it finds its pabulum. So dainty is it, that it is not all epidermic structures in which it will live. Its veritable home is certain parts of the horny layer of the epidermis. There is no evidence that it grows or exists in the mucous layer (rete mucosum). In hairs, in the substance of the nails, in the horny layers of the epidermis, in the space between the inner root-sheath and the cuticle of the hair, such are the parts in which in certain conditions it thrives and multiplies, but nowhere else. As Kuchenmeister long ago pointed out, it does not grow in living tissues.

But the fungus does not grow with equal freedom in all epidermic structures. Even on its own soil it is subject to conditions which apply to all fungi—temperature and moisture. To these two latter conditions it is probably correct to add moisture of a certain kind—but here we come to the region of hypothesis.

It is very possible, although on this point we have no evidence whatever, that the moisture which permeates the epidermis of certain parts of the body, and of certain individuals, is specially favorable to the growth of the fungus. The influence of temperature can be directly proven by experiments in an incubator, that of the human body being found specially favorable to growth; the influence of moisture is shown by the favorable soil the fungus finds in the epidermis of the inner surface of the thighs of certain individuals in hot and moist climates. Our knowledge regarding these conditions is still very elementary. If it were more complete we might possibly understand why ringworm is so much more persistent in some cases than in others. This more accurate knowledge, it is to be hoped, is within the reach of experiment.

No parasite can live in or on the human body without causing the formation of substances which are foreign to the healthy organism. The parasite has the power of splitting up the materials on which it lives. Some of these new substances it appropriates, the others are left as foreign elements.

These newly-formed substances act as irritants or poisons on the tissues with which they come in contact. Even the vegetable parasites of the skin possess this power in a greater or less degree. First in destructive power is the fungus of Favus, then comes Trichophyton tonsurans; lastly, and much less injurious than the first two, comes the fungus of Tinea versicolor

The irritation caused by the growth of Trichophyton in the epidermic structures leads to the symptoms which are characteristic of ringworm in its various forms. These symptoms are symptoms of inflammation, the special characters of the inflammation depending on the peculiar action exerted on the living tissues, particularly on the blood-vessels, by the new substances produced in the epidermis by the fungus appropriating the elements necessary to its growth. The fungus itself, and its new products, are the combined causes of this inflammation. The nature and degree of the symptoms thus produced depend on the anatomical structure of the part in which the fungus grows, and on the special irritability or vulnerability of the tissues of the patient. A consideration of these various symptoms leads us to the practical part of our task, that which concerns itself with the etiology, pathology, diagnosis, and treatment of ringworm.

CHAPTER II.

ETIOLOGY.

THE etiology of ringworm is concerned with the circumstances that lead to the contact of the spores of Trichophyton tonsurans with the surface of the skin; and with the condition of the skin that causes it to be an appropriate soil in which the fungus can take root and grow. First in order of the causes of the disease are the causes that lead to the contact of the spores with the skin. The most frequent and direct cause is that of the simple contact of one person with another, and, in the great majority of cases, of one child with another.

The hairdressers' tools are not unfrequently the conveyers of contagion. Not only does he of necessity cut the hair of children who unknowingly suffer from ringworm, but the parents of the affected children, who are advised to have the head shaved or closely cut, have no difficulty in getting it done by a barber. That spores may be conveyed from one child to another when towels, brushes, cravats, etc., are used in common, is easily understood.

It frequently happens that ringworm has existed in the head of a child for some time without its presence being known. Other children playing with such a child are readily infected. Children, in play, pass their hands through each other's hair, put on each other's caps, or bring their heads into direct contact. Spores are thus conveyed, directly or indirectly, from one head to another. This is probably the most frequent cause of ringworm being spread.

Ringworm of the body is not unfrequently communicated to adults who attend to children suffering from ringworm of the head. In this case it is usually found on the hands and arms. Direct contact of clothes, particularly with the caps of ringworm children, probably also occasionally communicates the disease. I have heard of a schoolroom in which the chil-

dren, as they entered, threw their hats and caps into a large receptacle provided for the purpose; and as in such a school it is almost certain that some of the children are affected with ringworm, it is quite conceivable that the disease may be occasionally thus conveyed. The crowding and grouping of children directly favors the spread of this disease, particularly under circumstances in which, as is commonly the case, no care is taken to secure that the children are free from it.

My own experience leads me to believe that ringworm of the head is more common in London than in any other large city; more common even than in Paris, and greatly more common than in Vienna or Berlin, and far more common still in proportion than in country towns and villages. Ringworm in the commoner schools of London has indeed become a great evil, with which it seems hardly possible to cope. No effectual means are taken to exclude affected children, and it is doubtful whether their exclusion, involving a long absence with probably insufficient medical care, will ever be seriously attempted. The very proper exclusion from the higher schools of ringworm children, although often a great hardship in individual cases, certainly tends to check the disease. But there is no such provision made in the populous schools attended by the children of the working and poorer classes. The consequence is, that there is in our midst an ever-present source of contagion, and the disease increases and multiplies to the great detriment of many children, both poor and rich.

Ringworm is occasionally acquired by contagion from the lower animals. This is probably not very frequently the case, but it undoubtedly occurs. The first authenticated case of the kind was published by Dr. Houlez, of Lorèze, who communicated a paper on the subject to the Medical Society of Toulouse, in 1845. Méguin mentions an instance of fifteen soldiers becoming simultaneously affected with Tinea circinata of the face and neck, from sleeping on horse blankets which had been used for horses suffering from the disease. Dr. Fleming has communicated to me the details of a case in which a dog, having become affected by lying on the cover of a horse which had the disease, communicated it to his master. I have myself observed ringworm in two sisters who had been fondling a dog which was affected; but who, so far as could be ascertained, had not been subjected to any other source of contagion.

This is the source for which it is always well to search when there is no history of direct contact with affected persons.

Possibly the disease may be communicated from laundries, but I know of no proof that it has occurred.

Certainly there are cases that occur from time to time in which it is not possible to discover any source of contagion. I was consulted in the case of a young lady who had tinea circinata on the back of the hand, and who lived in a house among whose inmates, it is certain, there was no case of this disease. She had not for a long time been in contact with any children; and she had no relations of any kind with persons who did not live in the same house as herself. It was impossible, in her case, to discover any source of contagion.

It has been stated that ringworm spores have been detected in the atmosphere of schools attended by children who had the disease. No weight can be given to this statement, and there is little doubt that the spores referred to were the ordinary spores that are always being deposited from the atmosphere of rooms, probably those of Penicillium glaucum.

The difficulty of tracing contagion is not peculiar to cases of ringworm. I have seen a case of scabies in a girl living in a country house, far removed from a town, who associated exclusively with her parents and governess, and when there was no other known case in the neighborhood. When the active agents in producing a disease are microscopic, we must expect, from time to time, to be foiled in tracing the source of contagion.

The skin of different persons, and different parts of the skin of the same person, vary in their suitability for the growth of the fungus. It does not grow, except in extremely rare cases, in the scalp of adults, and it grows more freely in moist parts of the skin than in parts that are dry. A steamy atmosphere, hydropathic treatment, the moist heat of the tropics, are conditions that favor its development.

The influence of moisture in the development of ringworm is shown in the form of body-ringworm common in tropical countries, the so-called Burmese or Chinese ringworm or Dhobie's itch. The skin of the inner surfaces of the thighs being constantly bathed in moisture, and the epidermis of the parts being naturally thin, the fungus is enabled to root itself in that part. But it may last there for years without any

other part of the body becoming affected, although it is inconceivable that in washing and other ways, spores are not carried indifferently to other parts of the surface. It is also certain that adults may in many cases handle children affected with ringworm without themselves becoming attacked by the disease, although it is beyond doubt that their hands, and probably other parts of their persons, may come in contact with spores. But if the skin of some persons is not at all liable to be affected by ringworm, and if some parts of the skin of affected persons seem to be proof against it, we are led to consider whether, in a perfectly healthy condition of the skin, ringworm can develop at all. It has, as every student of the literature of the subject well knows, been stated that sickly, scrofulous, and delicate children are more liable to the disease than others. This is a matter which experience alone can decide. My own experience leads me to believe that, while delicate children are as liable to the disease as others, yet perfectly healthy children with excellent constitutions are equally liable to it. The thin delicate epidermis of childhood seems to afford a natural soil for the fungus. My conviction is strong that children under the age of puberty, particularly those under the age of eight or nine, are all of them capable of developing ringworm if brought into contact with the fungus. At the same time there is no doubt that the rate at which the disease spreads varies much in different children. In some exceptional cases of young children a large part of the head may become affected with great rapidity; while in others the disease will be found limited to a few places, even if it has lasted some time. It is quite evident that the scalp of some children forms a more suitable nidus for the disease than that of others.

It is also very probable that while the fungus can attack and develop in the beard of some men, causing the disease known as parasitic sycosis, in that of most men it is probably incapable of taking root. The great frequency of ringworm of the scalp in London, and the great rarity of parasitic sycosis there, seem to me to show that in most men the hairs of the beard are proof against Trichophyton tonsurans.

But although the susceptibility in individuals varies, there is no reason to conclude that it depends on a feeble or sickly state of the skin. The requisite conditions are, there is reason

to believe, in no sense pathological. They probably consist in certain anatomical peculiarities of the epidermis which enable the spore to come within reach of the nutritive juices on which it lives, and in the moisture which probably in the first instance favors its attachment, and possibly acts on the cellulose envelope of the spore.

The conditions of development are found in the highest degree in the skin of young animals as well as of children. Calves are more liable to be affected than cows, and young horses than old ones. Young horses bought in France for the cavalry are, I understand, frequently found affected, particularly those which come from certain districts. It would seem that as there are cities in which ringworm is unusually prevalent among children, so there are districts in which it is unusually prevalent among young horses. In both cases the unusual frequency is doubtless due to facilities for infection. There is no more reason to believe that a special delicacy exists among children who have the disease, than among the young horses or calves among which it prevails sometimes almost epidemically.

The common idea that ringworm is associated with want of personal cleanliness is a mistaken one. Dirt affords no pabulum for the growth of Trichophyton, and as a matter of fact many cases which I see come from families in which the strictest cleanliness and care are practised. Whether the frequent scrubbing of the head of a closely cropped boy with soap and water would prevent the fixing of the spores in the soil may be a moot question. But the ordinary washing of the head in boys and girls, with hair of the ordinary length, seems to exercise neither a curative nor a preventive action.

As regards the proportion among the sexes, it has been stated that the disease is more frequent among boys than girls. Considering the habits of boys this is likely to be the case. But apart from schools, among the easy classes, I find the disease, so far as my own experience goes, sufficiently frequent in girls to show that sex has no influence on the soil.

Rank in life has no influence on the frequency of the disease, except that among the very poor indifference is shown regarding precautionary measures.

Pathology.

The pathology of ringworm is that of a specific inflammation; its special characters depending on the effects produced on the blood-vessels of the cutis by the growth of Trichophyton in the horny layers of the epidermis and root-sheaths of the hairs.

The various chronic inflammatory affections of the skin owe their peculiar manifestations to the fact that the cause of each of them exercises its injurious influence on the vascular structures in a more or less uniform and specific way. They have all of them certain features in common, and each of them special features which are characteristic. The features which ringworm has in common with other chronic inflammatory affections are alterations of color produced by congestion, alterations in sensation produced by the influence of effusion on the nerves (and possibly the direct influence on the nerves of foreign substances produced by the fungus), alterations in size caused by dilated vessels, and the usual deposits which accompany inflammatory congestion. Of the four classic symptoms of inflammation we have thus the rubor, dolor, and tumor more or less clearly represented.

In common also with the other chronic inflammatory skin affections, we have certain products of inflammation. There is a morbid desquamation of the epidermis; either simple desquamation in the form of dry scales, or the scales are agglutinated by serous or purulent discharge, and crusts and scabs are formed.

Of the special features of the inflammation caused by Trichophyton are to be adduced the peculiarities of its localization, which is non-symmetrical, and the fact that it affects by preference certain parts of the body. The eruption is as a rule distinctly marginated, and remains superficial except in very rare instances, leading to nothing approaching to permanent destruction even of the most superficial elements of the skin. As a rule, even after it has lasted a long time, it leaves no permanent trace. In brief, the poison by which this inflammation is caused is sufficiently powerful to lead to effusion from the blood-vessels with its usual results, but not to cause permanent destruction of the mucous layer of the epidermis or connective tissues of the cutis.

The histological changes which accompany this inflammation will be fully dealt with in treating of ringworm of the scalp.

Although the growth of Trichophyton always runs through the same stages on whatever part of the body it has taken root, and although the pathological changes to which it gives rise are always essentially the same in their nature, yet the clinical appearances which it causes, and the management of the disease, vary according to the region which is infected. It is thus we have the several varieties of ringworm known as ringworm of the head, of the body, of the nails, of the beard, and tropical ringworm, chiefly affecting the inguinal region. It is necessary, therefore, to treat of ringworm of the several regions separately; and as first in order of importance I shall begin with ringworm of the scalp.

CHAPTER III.

RINGWORM OF THE SCALP.

RINGWORM of the scalp is so rare in adults that it may be correctly stated to be exclusively a disease of children. Lailler and Hardy have stated that they have never seen a case in adults. It does, however, occur. I have myself seen two cases, one of them being that of a woman, who had a patch about the size of a shilling in the centre of the head, half-way between the forehead and the vertex. She contracted the disease evidently from her children, who suffered from it. But there is no doubt of its very great rarity in adults. This is a fact which it is important to bear in mind. Some years ago a lady came from a distance to consult me about an imagined ringworm of the head. For six months extraordinary precautions had been taken in the household to prevent her giving ringworm to her children, precautions that led to the very great inconvenience, if not distress, of all the members of her family. What she was really suffering from was a circumscribed patch of eczema, originally produced by an irritating hair-wash; and the disease yielded in a few weeks to appropriate remedies.

Method of Examining the Head.—In examining the head of a child who is suspected to have ringworm, two things are requisite: good light and a lens. The shorter the hair the easier the examination. In the case of a boy it is convenient to pass the hand close to the scalp and move it slowly against the hair in the direction contrary to that in which it lies. By this means it is possible to bring into clear view successively every part of the scalp. In the case of a girl with long hair this somewhat rapid method is not practicable, and it is necessary to use both hands and open out the hair in successive gaps, the procedure requiring considerable time and patience.

As regards the choice of a lens, any ordinary hand-lens, or one similar to that used by watchmakers, does very well. The

magnifying power desirable is from two to three diameters. A person with acute vision may dispense with a lens, but it is certainly an advantage. The patient should be placed in such a position that a good light will fall directly upon the part examined.

Progress.—An attack of ringworm of the head is rarely observed from the beginning, some days at least having elapsed before the attention of parents or nurses is called to the appearances which lead to its being suspected.

Sometimes the attention is excited by the head being itchy. The child is observed to scratch, and when it is examined, part of the skin is found to differ in appearance from the rest. This itching, which is probably always present, may be so slight as not to attract attention; and the first suspicion of something being wrong is due to the nurse or the hair-cutter observing that parts of the head are bald or scurfy.

When the child is brought for examination, it is found that one or more parts of the scalp have undergone certain changes which affect both the surface of the skin and the hairs.

Most usually, if the disease has been detected early, one or more patches, varying in size from a split-pea to a shilling, rather discolored and more or less covered with scurf are found. They are of a faint brownish color or of a brownish red, or the color may be only very slightly changed.

They are, as a rule, slightly raised above the level of the surrounding skin, and have a somewhat dirty scaly appearance. Sometimes, when very little change in color is to be observed the patch is conspicuous chiefly by being scaly. These appearances are due to congestion of the skin caused by the parasite.

The most constant symptom is desquamation or scaling. The patch is usually circumscribed, and a scaly circumscribed patch on the head of a child must always be viewed with grave suspicion. Certain appearances, due to changes in the hairs convert the suspicion into a certainty, and the first thing we do when a child with such a patch or patches is brought before us, is to examine carefully the condition of the hairs. To understand how the various appearances of the hairs are produced, it is necessary to premise certain facts regarding the relation of the fungus to the hair-shaft. The fungus enters the hair-shaft near the hair-root well under the surface

of the skin, and grows upward into the shaft, and at the same time with great luxuriance between the sheaths of the hair and the shaft.

The consequence of the growth of the fungus in the hair follicle is the production of epidermic débris around the hair-shaft, which again leads to a projection of the epidermis upward around the hair. The hair is seen to be surrounded, at

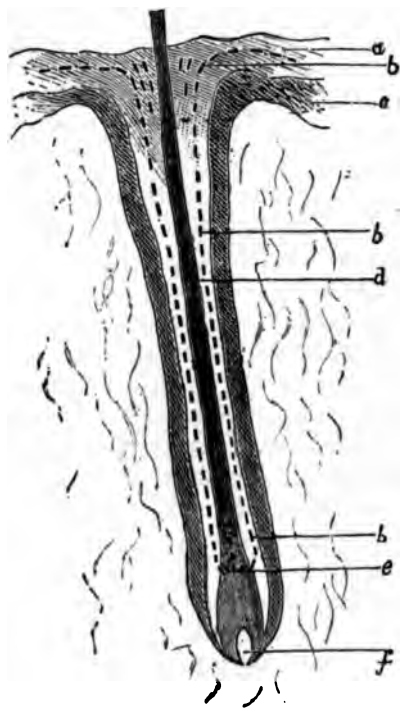

FIG. 10.—Scheme Illustrating the Author's Views Regarding the Invasion of the Hair-shaft by Trichophyton. *a*, Horny layer of epidermis; *b*, line of growth of the fungus; *c*, rete mucosum; *d*, hair-shaft; *e*, the point where the fungus enters the hair-shaft; *f*, the hair papilla.

its exit from the scalp, with a dull, gray, lustreless sheath. The projecting cone out of which it seems to grow causes an appearance of shagreen or goose-skin. This is the first distinctive sign of the hair being affected with Trichophyton, and of the disease being ringworm.

But the growth of the fungus inside the shaft of the hair leads to further and even more distinctive appearances. The closely cemented epithelial cells, out of which the hair is built

up, are dissociated by the masses of growing fungus. The hair, consequently, becomes thicker, fatter, and loses its elasticity. When bent under the finger it does not spring back again into its normal position, thus contrasting in a very marked manner with the other healthy hairs by which it is surrounded.

The affected hairs become bent, twisted, and no longer lie in a parallel direction to that of the healthy hairs of the part of the head. They have been compared appropriately to the stalks of corn beaten down by winds and rain; the stem being broken they no longer regain their former position.

As the fungus grows the hair breaks off entirely, the outer part disappears and is carried away by the comb or brush to other parts of the head, where it deposits some of the spores by which it is loaded, and new foci of the disease are started. The hair does not break off quite on a level with the skin, a stump usually of about $\frac{1}{16}$ to $\frac{1}{8}$ of an inch being left.

The same physical qualities which characterized the hair before it broke are retained by the stump. After all the hairs in and around the patch are closely cut, the stumps of the diseased hairs are found to differ from other short hairs which may be of the same length. They point in various directions, are thick and distorted, and have a lustreless appearance. These stumps form the most characteristic sign of the disease, and the relations of the stump to the uninfected hairs give rise to varieties of ringworm which have been divided somewhat arbitrarily into classes, but which pass indefinitely into each other.

A patch of ringworm may present a well-marginated appearance; all the hairs within the margin having broken and nothing being left but short stumps growing out of minute, slightly elevated cones of epidermis. If left to itself the size of this patch gradually increases. This form is the typical tinea tonsurans; and, except in size and position (sometimes even in these respects), simulates with great closeness the priest's tonsure. The scaly, bald patch, the surface of which is studded with irregular stumps of hairs, presents a distinctive appearance which is hardly mistakable by those who have seen it once. It is well recognized by women of the poorer classes in our large cities, certainly in London.

But the tonsure may not be clean. It is certain that of

the hairs of the scalp of the same individual all are not equally readily affected by Trichophyton tonsurans. Consequently we have areas containing a certain proportion of stumps, and a certain number of long, unaffected hairs. We have thus patches in which the hair is thin, with characteristic stumps

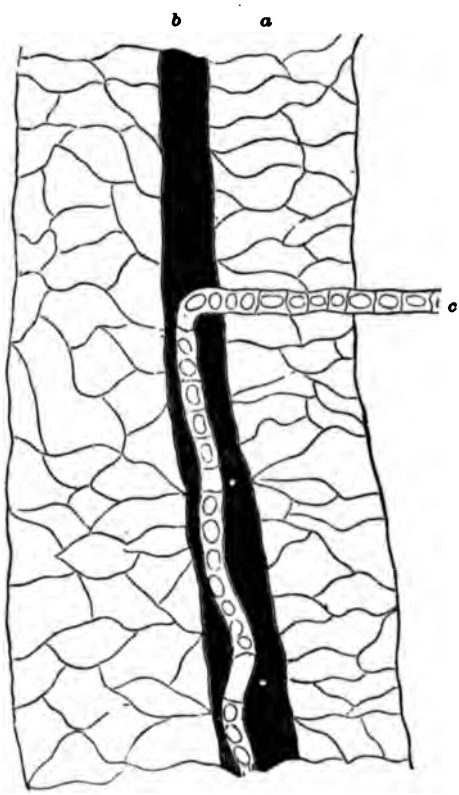

FIG. 11.—A Hair Treated with Strong Potash solution, by which it has been Burst. A solitary mycelium is seen occupying the centre of the hair. By an accident of the preparation part of the mycelium had fallen out of the cavity in the hair and floated in the solution. *a*, The hair; *b*, central cavity in the hair exposed by the potash solution; *c*, mycelium containing spores.

distributed in smaller or greater numbers between the hairs. But even in this case the hairs which at first withstood the disease in most cases gradually succumb. The number of unaffected hairs becomes steadily fewer, and the number of stumps larger, until, eventually, we have the tonsure complete.

The distribution of the fungus among the hairs may follow a still more irregular course. In addition to one or several more or less complete tonsures we may have a number of isolated stumps scattered among the healthy hairs; only observed by being carefully looked for, and very apt to escape the attention of the patient's friends. It is never safe to accept the statement of parents and nurses regarding the extent of the disease. Their attention is confined, as a rule, to the one or more defined patches; and they are in complete ignorance of the existence of discrete, isolated, diseased stumps.

It is in this form of ringworm, characterized by solitary stumps, that the diagnosis presents difficulty and requires a trained eye. Boys affected with it are sent back again and again by the medical officers of schools after their parents, and sometimes their medical attendants, have considered the disease cured. In this form again the characteristic sign is the stump.

Turning our attention from the hairs back to the scalp, we find again considerable differences in its behavior, and these differences have been and may be taken as a basis for establishing an indefinite number of varieties of the disease.

I have already stated that the characteristic reddish-brown color of the patches may be scarcely perceptible or even absent. The color of the ringworm-patch may be a bluish-gray, this effect being produced by the accumulation of epidermic débris, or it may not differ at all from the color of the surrounding skin. No visible sign of congestion may be present. Again, as regards scaliness and desquamation, the signs may be reduced to a minimum: the epidermic scales may be produced so slightly in excess as not to strike the eye. But this sign is never entirely absent around the stumps where partially detached epidermic scales may usually be seen.

The changes of color produced by lesions of a more pronounced character than desquamation, by the formation, namely, of papules or pustules, need not be separately described.

So far we have limited ourselves to the appearances produced by desquamation, the most common accompaniment of disease of the hairs. In other cases the symptoms are of a more pronounced type. The inflammation of the hair-follicle produced by the parasite may be so acute that an inflamma-

tory papule is formed around the base of each affected hair. This papule, which is red and projecting, may not advance to a further stage, although usually it is only transitional to that of a vesicle and pustule.

A minute pustule may be found around the base of each hair. In some rare cases the entrance of Trichophyton into a hair-follicle leads at once to suppuration, one or more affected hairs are cast off with the pus, the hair follicle is destroyed, and a small bald patch remains. The disease is cured.

There are other cases in which the lesions can hardly be termed either papule, vesicle, or pustule. We may find a series of raised inflammatory patches covered with scabs, which, when they are removed, lay bare an oozing surface. These patches are scattered discretely over the head, the lesion somewhat resembling that of a boil. But the appearance is not exactly that of a boil. The inflamed area is irregular, is never quite circular, is usually flattened at the top, and scabs more than a boil does.

This form is likely to be confounded with simple eczema, more particularly as there are usually not many diseased hairs. It is apt to be chronic, as the inflammation is not sufficiently acute to lead to the destruction of the hair and a spontaneous cure.

It is evident that an almost unlimited variety of clinical pictures may be drawn of the appearances produced by these varying conditions of the affected skin and the diseased hairs, but in practice the various types which might be described from the extreme cases are practically found so to run into each other that it is very doubtful whether it is useful to make distinctions which must always be more or less arbitrary.

Nor is there any well-defined limit as regards time. A ringworm which has lasted a fortnight, and which is spreading rapidly, might well be termed acute, and a ringworm which has lasted two years and is not spreading may, with perfect accuracy, be termed chronic. But that after all may not express more than that the one case has lasted a short time, and the other a long time. A ringworm that has lasted three months is often indistinguishable in appearance from one that has lasted three years. It is quite permissible to speak of chronic and acute ringworm; but as the symptoms

and pathological conditions are essentially the same in both cases, for practical purposes chronic and acute ringworm need not be placed in separate categories.

Special attention must, however, be directed to the variety of ringworm in which, from the resistance on the part of many of the hairs to the development of the fungus, we have, instead of well-defined patches, numbers of isolated stumps scattered over the head. Very often this condition is associated with one more or less well-defined patch on one part of the head, often on the vertex. As the source of infection in many such cases has been long in operation, and as these isolated hairs have not become the centre of new tonsures, we are bound to assume that for a time, at least, a large proportion of hairs in the head of the individual are not susceptible to infection. What this condition of non-susceptibility is can only be matter of conjecture.

We know that the hairs of the scalp of the adult are not susceptible of ringworm, and it is possible, even probable, that in the cases we are describing a great majority of the hairs have undergone the change, whatever it may be, which enables the hairs after puberty to withstand Trichophyton. These cases are in many senses important. They are exceedingly obstinate as regards treatment; possibly the very condition which enables some of the hairs to resist the fungus, renders treatment more futile in the hairs which have become affected. They are further important because they are apt to be overlooked, and so long as they exist the patient is not safe against fresh and further extension of the disease, and he is a perennial source of infection to other children. I have known boys in which this form existed go on a long time without any extension whatever of the disease, a few isolated obstinate hairs remaining to defy treatment unless they were destroyed altogether.

When there is reason to believe in the existence of this form of scattered or isolated ringworm, the patient's hair should be closely cut, being kept not longer than from one-fourth to one-third of an inch, and the stumps carefully sought for in a good light by passing the forefinger of the left hand slowly against the hair, while the scalp is carefully examined with the assistance of a lens, which is held in the right hand. When the stump is detected its position should be marked

with an aniline pencil, a drop of ink, or a minute drop of solution of nitrate of silver, so as to mark its position; otherwise it may be impossible to find it again. The examination of such a head requires much time and patience; and parents and nurses of sufficient intelligence and good-will for this purpose are not the rule. It will be observed that in this form also the only criterion is the existence of the stump. No broken hair, no certainty of ringworm.

Occasionally the detection of the stump is rendered unusually difficult by the fact of its having broken at the level of the follicle. In this case instead of a projecting stump, a minute black plug takes the place of the hair. Such a black plug is in itself very suspicious, and should be watched. As the hair does not cease to grow, in a few days the black point will have developed into a minute stump.

The appearances caused by ringworm of the head are, as a rule, the more striking the darker the hair of the individual. When the hair is fine and fair the general appearance catches the eye less readily, and the individual stumps are much more difficult to observe.

Although a patch of ringworm is usually more or less circular it is not always so; it may be elongated or oval, or, while retaining these forms as a whole, the borders may be more or less irregular. The latter condition is present in all degrees in different cases until we come to patches which are not circumscribed at all, the complete, or almost complete, baldness in the centre of the patch becoming less and less marked as we pass from the centre.

The coalescence of two or more patches sometimes leads to a gyrate form.

The rapidity with which the disease progresses varies very greatly. In some children it runs a rapid course, large bald patches being formed within a few weeks. In very young children the progress is even quicker. In a child between two and three years old with fair hair I have observed the disease sweep over the entire scalp with great rapidity. But these cases are exceptional, usually weeks elapse before the patches acquire much size. Accurate data regarding the time required, in an average number of cases, for the disease to spread over a large part of the head are not easily obtained, because treatment, however ineffectual it may often be in

quickly curing the disease, is at least to be credited with the speedy arrest of its extension.

The differences in the rapidity with which the head is invaded in different children are not caused by any varying virulence of the fungus, but depend exclusively on the fact that the head of one child forms a more favorable soil than the head of another, and it is almost certainly the case that one part of the head of the same child favors development more than another part.

Differential Diagnosis.—Although with care the diagnosis of ringworm of the scalp is always, or nearly always, to be made without the use of the microscope, yet there are certain diseases from which there may be some difficulty in distinguishing it. The superficial inflammation of the scalp caused by Trichophyton may be considered an artificial eczema, and the question may arise when the patient is brought for examination as to whether we have to deal with ringworm or with simple eczema. As a rule the diagnosis is not difficult, but there are cases in which we are glad to confirm our opinion by microscopical examination of the hairs. Simple eczema of the head is, however, attended with much greater itching than is the case with ringworm, and in young children is usually spread over a large surface and not limited to defined patches, and notwithstanding that a considerable portion of the head may be covered with crusts and exude serum abundantly, the broken hairs distinctive of ringworm are not fond. It has been stated as a diagnostic sign that while the hairs in ringworm come out easily they are firm in eczema. This is by no means always the case. In any inflammation of the scalp which penetrates sufficiently deeply the hairs may become somewhat loose, and I have in cases of eczema capitis extracted hairs from an infiltrated and oozing surface which came out with very little traction.

There are cases which present unusual difficulty. I have under my care at the present time a boy who had extensive ringworm of the scalp which yielded to treatment, with the exception of one small patch about the size of a threepenny piece on the vertex. This patch contains a few obstinate stumps which have been rebellious to all ordinary remedies. One day the boy was brought to me presenting a great number of isolated patches over his head varying in size from a

split pea to a shilling, but the patches were not round, and had no uniform shape. They were covered with thick crusts, and when the crusts were removed the base on which they rested was found to be swollen, red, and oozing a clear serum. It was impossible to shut out the suggestion that infection had been carried from the old obstinate patch to other parts of the head, and that we had to deal with an outbreak of acute pustular ringworm. But there were no broken hairs and no stumps, although the hairs came out easily. There were a few pustules on the face, and within a few days his face and ears presented the appearance of an ordinary impetiginous eczema. The microscope showed that the patches were not of the nature of ringworm, and the result of treatment showed that we had to deal with a case of simple eczema.

Another form of artificial eczema is liable to be confounded with ringworm of the head, namely, that which is caused by pediculi. Pediculosis capitis occurs more especially on the occipital region. The symptoms are so far acute that an oozing crusted eczema occurs in a great many detached points. The inflamed patches are found most plentiful toward the nape, on which there are generally signs of scratching. The appearance is characteristic enough to be unmistakable by those who are familiar with it, and the diagnosis need hardly depend on detecting pediculi, as in a susceptible child one or two are enough to excite an extensive eruption. The patches are small and bear the marks of scratching, and the hair is matted and moist. There is, of course, an absence of stumps, and above all the disease is rapidly cured by appropriate treatment with any of the well-known applications which destroy pediculi.

Pityriasis of the head can hardly be mistaken for ringworm. Is it not an affection to which children are liable, occurring most frequently in young adults. The surface of the scalp is slightly reddened and there is an abundant formation of fine branny scales which are found mixed loosely with the hair. Although if the disease persists it is apt to lead to premature baldness, it leads to no breaking of the hairs and no stumps are found.

Seborrhœa capitis might possibly be confounded with ringworm. It is an affection quite distinct from pityriasis capitis, being caused by an excessive secretion of sebum. The hairs

are matted together or glued to the scalp. The scales and crusts thus formed are usually far in excess of those known in ringworm. They adhere to the skin, which is, however, not the seat of any acute inflammation, and usually they form a large coherent crust which extends in a sheet over a considerable part of the head. Although this affection also leads to baldness when long persistent, it does so by a gradual obliteration of the hair-follicles and not by the destruction of individual hairs. If the greasy masses are first softenend with oil and then washed with soap and water, the absence of ringworm hairs and stumps will be apparent.

Psoriasis capitis might easily be mistaken for ringworm. Psoriasis occurs on the scalp in the form of small or large, usually small, patches, circumscribed and chronic. The scales on the patch are thicker and more coherent than is usually the case in ringworm, and are not glued together like scales in seborrhœa. Usually there is a history or the actual presence of psoriasis on other parts of the body, more particularly on its common seats. Its presence on these positions facilitates the diagnosis. The hairs on the scalp will be found to be growing unbroken in the patch.

The disease, however, with which ringworm of the scalp is most apt to be, and is most frequently, confounded, is alopecia areata. As a rule the diagnosis between these affections is easy. Sometimes it is difficult, but I believe that without having recourse to microscopical examination, an accurate diagnosis is always possible. The most striking difference between a patch of ringworm and a patch of alopecia areata is the absence of scales and stumps in the latter. The bald patch of alopecia areata is entirely hairless, the skin being white and smooth, and often appropriately likened to the surface of a billiard-ball. But the difficulty has arisen because it has not been recognized that these characteristic conditions are not absolute. In a great number of cases of alopecia areata very fine short stumps are found on the border of the patch; and in some cases, if carefully looked for, and if the part has not been recently washed, very delicate scales may be detected. It does not require much practice to detect the fine stumps; the scales usually escape observation. But these stumps ought not to be confounded with those of ringworm. They are all broken off on a level with the skin, so much so

that it is difficult with fine forceps to get sufficient hold to extract them. They do not present the irregular and unsymmetrical appearance of the stumps of ringworm, which, even when some of them are very short, will always in part be found to project sufficiently to show that the hair is bent and twisted. Familiarity with the two diseases is sufficient to prevent the stumps of the one being confounded with those of the other. But even without this familiarity the diagnosis is fortunately made easy by the microscope, the stump of ringworm being full of spores of Trichophyton, that of alopecia containing none.

On the other hand, a patch of ringworm may, very rarely, simulate alopecia areata. If the inflammation caused by Trichophyton leads to suppuration and the destruction of the follicle, we may have the patch left white and bald; but if the disease is active, the characteristic signs of ringworm will be found on the margin of the patch.

Cases are occasionally described of alopecia and ringworm existing on the head of the same child at the same time. There is no reason why the two diseases should not co-exist. Where ringworm is very common, it would be extraordinary if, from time to time, a ringworm child did not, as well as any other child, contract alopecia areata. But, without throwing any doubt on the fact of their occasional co-existence, I am satisfied from observation of alleged cases that some of them at least are cases of ringworm in which baldness caused by Trichophyton has been mistaken for alopecia. There is absolutely no connection between the two diseases.

Favus can hardly be mistaken for ringworm. It should certainly not be mistaken by any one who had seen a case or who had even seen a good picture of one. And any one at all familiar with ringworm would at once, in a case of favus, recognize that he was dealing with something different. The so-called cups of favus are perfectly characteristic. The disease is a comparatively rare one, and its fungus can be distinguished by the microscope.

To resume, the criterion on which we must always fall back in distinguishing ringworm of the scalp from the other diseases we have mentioned is the existence of broken hairs or stumps. In no other of these diseases, except favus and alopecia areata, do the hairs break. With favus a mistake is

hardly possible and would be inexcusable. With alopecia areata the appearance of the stumps is characteristic, and where the clinical experience of the observer is not sufficient to establish a diagnosis, the microscope will decide the question.

Although the naked-eye appearances are thus sufficient to establish the diagnosis, we have, fortunately, a means of making the diagnosis certain by examining for the presence of Trichophyton in the hairs. The methods of examination are very simple, and very little familiarity with the use of the microscope is required to enable any one who chooses to become more or less expert.

Microscopical Examination of the Hairs.—Simple as the examination of a hair for ringworm-spores is, it requires an elementary acquaintance with the use of the microscope and a certain familiarity with the appearance of Trichophyton. No one would like to take the responsibility of pronouncing that a hair contained the fungus who had never seen the fungus before. The necessary familiarity should be acquired by every practitioner, and fortunately this is not difficult to accomplish. Stumps should be extracted from a recognized patch of ringworm, and one or more examined.

The usual and best mode of examination is to place the stump in a drop of liquor potassæ, or of an aqueous solution of potash, and wait for a short time before examining. The effect of the potash is to dissolve out fatty matters, and to dissociate the epithelial cells of the hair and thus to bring the fungus clearly into view. When time is an object it is well to use a strong solution of potash. For this reason I generally use a 10 or 20 per cent solution, and for ordinary purposes I find this is a convenient strength. Where it is for some reason desirable to preserve the hair as a preparation, a weak solution, say 5 per cent, is best; where it is desirable (for example, in a stump loaded with fatty matters) to split the hair to pieces and lay bare the fungus as rapidly and thoroughly as possible, 20 per cent should be used. But as a rule ordinary liquor potassæ acts very well.

In some cases the hair is so charged with oil-globules that it is impossible, even after the widest experience, to tell whether we are looking at minute droplets of oil or at spores. In such cases it is necessary to dissolve the oil, and ether,

chloroform, and alcohol are recommended for the purpose. But even in such cases a strong solution of potash is sufficient if we can afford to wait. If a drop of 20-per-cent solution is used we shall find in half an hour that the oil-globules have disappeared, and that the duller, less-refractive spores have come into view.

The spores of Trichophyton as observed in a hair are not always equally round, when they are closely packed in masses. Their naturally round shape is somewhat modified by mutual compression, and they may sometimes be more correctly described as rounded with a tendency to an oblong shape. They are best recognized by their fairly uniform size, which is considerably smaller than that of a red blood-corpuscle, and by the manner in which they are closely packed in the hair.

Although there are mycelia in the hair shaft, these are not usually seen in ordinary examinations, but after a strong solution of potash is allowed to act for some time, they are brought into view. Indeed, whenever we find masses of spores we know that there are, or have been, mycelia, for it is in the mycelium that the spore is produced.

However, what is usually seen in the ringworm hair or stump is a mass of spores in which a tendency to linear arrangement may be observed. This is not the appearance seen if we chance to examine a hair which has just been attacked by the fungus. In such a hair we often find the hair-shaft intact and entirely free from spores, but in the root-sheath which is extracted with the hair we find mycelium ramifying luxuriantly. In such a hair the naked-eye signs of ringworm have not been developed, the hair-shaft being sound and unbroken.

In dark-haired children (as in black horses), when the hairs have been long affected by Trichophyton we sometimes find on splitting the hairs with strong solution of potash that the mycelium is loaded with pigment, and in the horse particularly I have found free spores the walls of which were black with pigment.

As an example of this infection or absorption of pigment by mycelium of Trichophyton, I give an engraving of the appearance found in a ringworm-hair from a dark-haired girl, who was the subject of chronic ringworm. The drawing also illustrates the existence of mycelium in which spores have not

yet formed in the shaft of a hair. It further shows how deeply in the hair the fungus grows. In these instances we have the mycelia growing close to the very limits of the horny substance, stopping before they touch the living cells of the hair-papilla, but near enough to be favorably situated for

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 12.—Appearance of a Hair Infected with Spores of Trichophyton. Examined in solution of potash with a magnifying power of about 300 diameters.

Fig. 13.—A Hair Extracted from the Scalp of a Dark-haired Child. The mycelia (dark with pigment) are seen to be situated in the deepest part of the hair, extending into the bulb. *a*, The bulb of the hair.

Fig. 14.—Five of the Mycelia shown in Fig. 13 highly magnified. Septa are seen dividing the protoplasm of the mycelium, the protoplasm containing pigment which has penetrated the mycelial sheath. The pigment is in the protoplasm and not in the sheath, and is more plentiful in some of the divisions than in others, the septa apparently forming obstacles to its easy diffusion.

absorption of the pigment with which the root of the hair is richly supplied.

Pathology of Ringworm of the Scalp.—Symptoms so marked as those which have just been described point to a special histology of ringworm, and a study of the histological changes necessarily leads to speculation regarding the mechanism by which the growth of the fungus has produced them.

At the outset we are met by the question of the exact anatomical position of the fungus. Küchenmeister stated in 1855, that the parasite can only live and increase in the substance of the hair-shaft itself and in the crusts which are found on the scalp; and that it is never found between the cells of the epidermis. Kaposi, on the other hand, has stated that the fungus is found between the cells of the root-sheath. In more recent times Dr. Robinson, of New York, has stated that conidia are found even in the perifollicular tissue; and in his "Manual of Dermatology" (p. 594) he gives an engraving, in the explanation of which he states that spores and mycelia are seen in the mucous layer and in the corium.

I am able to confirm the statements of Küchenmeister, and am unable to explain those of Dr. Robinson. The subject was carefully investigated by myself in the skin of the horse in 1878. A great many sections were examined, and in no one instance were the spores found in the rete mucosum or in the corium. They were found invariably between the hair-shaft and the inner root-sheath of the hair. The spores were seen so distinctly in these sections that if they had passed into the connective tissue or root-sheaths they would necessarily have been seen there.

Dr. Frederick Taylor presented a paper to the Royal Medical and Chirurgical Society, in which he came to the same conclusions for the human subject as those which I had come to regarding the skin of the horse. Dr. Taylor, whose studies were made on the skin of a boy who had long been subject to ringworm, and who died in Guy's Hospital of disease of the brain, had ample material with which to work, and would certainly have seen the spores in the rete mucosum or corium if they had been present. As in the sections of the skin of the horse, so in Dr. Taylor's case, the spores were found between the hair-shaft and the internal root-sheath; and in no instance were they found in the living tissue.

Dr. Taylor's examination and my own, therefore, entirely bear out the statement of Küchenmeister, and I believe it may be accepted that Trichophyton tonsurans only lives among epithelial cells which have more or less undergone the horny change, and that it cannot exist in living tissues.

Examination of sections from skin affected with ringworm reveals certain appearances which would not be suspected by

examining extracted hairs. Within the cutis it is found that the hair-shaft becomes bent, first at an obtuse and then nearly at a right angle, and finally breaks. The lower end of the upper part of the broken shaft is pushed by the projecting straight lower part into a semicircular form, which causes a

FIG. 15.—Vertical Section through a Portion of the Skin of a Horse Affected by Tinea Tonsurans: Illustrative of the Position of the Fungus and the Inflammatory Changes in the Cutis. *a*, External-root sheath; *b*, hair-shaft. The small dots in the clear space outside the hair-shaft represent the spores, which are lying on the internal root-sheath; *c*, connective tissue of the cutis; *d*, detached epithelial cells lying in a minute abscess in the rete mucosum; *e*, a minute abscess cavity in the rete mucosum filled with exudation cells. (This figure, as well as well as Figs. 17 and 18, are copied, by permission of the Council of the Royal Medical and Chirurgical Society, from a paper by the author "On the Condition of the Skin in Tinea Tonsurans," in vol. lxi. of the Medico-Chirurgical Transactions.)

corresponding bulging of the external root-sheath. The explanation of this is that when the shaft has become disintegrated by the multiplication of spores it bends under the pressure from below of the growing hair and finally breaks. The fracture of the shaft frequently takes place at a level with the sebaceous glands.

But very striking changes take place in the cutis and at a considerable distance from the position of the fungus. These changes are characteristic of the inflammatory process. Numbers of white blood-cells are found in and around the walls of the blood-vessels, and to a less extent between the bundles of connective tissue. They are also found, sometimes in great numbers, between the cells of the rete mucosum, which may become disintegrated and disappear.

The horny layer itself may also break down, and in extreme cases the cutis is covered with a purulent discharge. The superficial blood-vessels are found distended with blood-corpuscles, and cavities are observed in the rete mucosum filled with white blood-cells; in other words, minute abscesses form in the rete mucosum.

These histological changes afford an abundant explanation of the symptoms we have described in the section on the progress of the disease. It is clear that the fungus gives rise to inflammatory or destructive processes which injure the walls of the blood-vessels, and lead to effusion sufficient in degree to produce great changes in the rete mucosum. The exact mechanism by which these changes are effected is not evident, but we may infer that as the growth of the spores in the hair-shaft necessitates the decomposition of organic substances, some products of this decomposition are left unassimilated, and if they are soluble they will find their way between the cells of the root-sheaths to the substance of the cutis and to the walls of the blood-vessels.

The effusion of colorless corpuscles takes place around the walls of the blood-vessels even in the deeper strata of the cutis, showing a certain extension of the inflammatory process from the parts directly attacked, and adding additional proof of the irritant nature of the poisonous substance set free by the fungus.

Does the influence of this irritant extend beyond the cutis? In other words, is the inflammation produced by Trichophyton in the scalp of a child, when it involves a considerable extent of surface, and when it lasts for some time, likely to exert an injurious influence on the health of a child? It is generally stated by dermatological writers that weak, delicate children and scrofulous children are more liable to be affected by ringworm than others. Statements of any kind are so often

copied by one author from another, that it is doubtful what proportion of authors make these statements from the results of their own observations. It is a fair question whether the

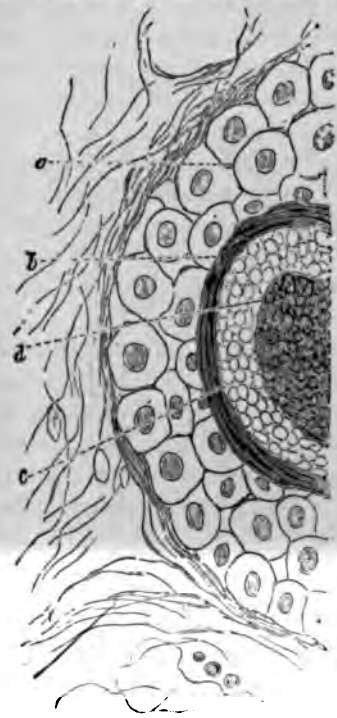

FIG. 16.

FIG. 17.

FIG. 18.

FIG. 16.—From a Transverse Section of the Scalp of a Child Affected with Tinea Tonsurans, Showing the Position of the Spores. The figure is based on a drawing by Dr. Frederick Taylor in vol. lxii. of the Medico-Chirurgical Transactions, permission to use the drawing being kindly given by Dr. Taylor and the Council of the Royal Medical and Chirurgical Society. Only half of the drawing has been copied, but it has been enlarged to double the size of the original. The spores are for the sake of clearness enlarged out of proportion. *a*, The cells of the external root-sheath; *b*, the internal root-sheath; *c*, the spores, lying between the internal root-sheath and the hair-shaft; *d*, the hair-shaft.

FIG. 17.—From the Skin of the Horse: Illustrating the Fracture of an Affected Hair by the Projection of the Growing Shaft from below. *a*, Cutis; *b*, sebaceous gland; *c*, external root-sheath.

FIG. 18.—Vertical Section through the Skin of a Horse Affected with Tinea Tonsurans; Illustrating the Inflammatory Changes Produced in the Cutis and Epidermis by the Fungus in the Hairs. *a*, Rete mucosum; *b*, horny layer of the epidermis; *c*, a raw surface, denuded of epidermis and covered with amorphous matter containing many exudation cells; *d*, blood-vessels distended with blood-corpuscles; *e*, a hair which was seen under a high power to contain spores of *Trichophyton*.

weakness and delicacy, and signs of a scrofulous tendency in children who are the subjects of that diathesis, are not due to

the absorption by the blood-vessels of a depressing organic poison continually being set free by the growth of the fungus. The data which would enable us to answer that question have not yet been provided. But as I am certain that the most healthy children may and do suffer from ringworm of the scalp, I am induced to believe that, if the proportion of ringworm children who are delicate is larger than the proportion of delicate individuals among ordinary children, the delicacy should be considered to be the effect and not the cause.

Treatment of Ringworm of the Scalp.

It is possible to treat ringworm of the scalp without cutting the hair, but it is always unadvisable to do so. If the hair is left uncut it is difficult to see the extent of the disease, it is difficult to apply remedies thoroughly, and it is difficult to be sure that there are not undetected patches. If there is only one or perhaps two well-defined patches it may be sufficient simply to cut the hair for the distance of three-quarters of an inch around the patch, at the same time, particularly if the patient is a boy, ordering the hair of the rest of the head to be cut very short, so as to facilitate observation.

If the patient is a girl and the parents object strongly to the hair being cut, a concession may be made, and the hair, excepting that which surrounds the area, may be left, on the understanding that the scalp shall be thoroughly examined daily by a competent person. When there are more than two or three scattered patches the whole hair should be cut.

It is not necessary to shave the head; it suffices if the hair is cut with scissors close to the scalp.

The long hairs of the scalp being thus as far as possible cut out of the way, the next thing to do is to order a preventive lotion or ointment for the whole of the head, in order to destroy any spores that may be on the surface.

A lotion of two-per-cent solution of carbolic acid in water, or of boracic acid dissolved in alcohol, answers this purpose, and should be thoroughly applied with a sponge once daily. A simpler and equally good preventive is boracic ointment, with which, if it is used, the scalp should be kept smeared.

Having mapped out the patches by cutting the hair, and having ordered a disinfecting lotion or ointment to prevent

the spread of the disease, the next task is to endeavor to cure the patches which exist. As a rule it is not an easy task, as may be inferred from the great number of remedies whose efficacy has been the subject of more or less enthusiastic praise. When it is asserted of a remedy that it cures many ailments it may be taken for granted as very likely that it cures none, and when many remedies are recommended in the treatment of a disease it is only too probable that not much confidence can be placed in any of them. Unfortunately the latter proposition applies to the treatment of ringworm.

The many vaunted specifics only too often leave the practitioner in the lurch. Disappointed with one he grasps at another, until the changes have been rung on an endless variety of so-called cures; and at last the parents, wearied and disappointed, take their child from one medical man to another and finally come to the conclusion that the disease is incurable. I am satisfied that the best way to avoid these discouraging results is not to fly from one remedy to another but to take care that the remedies selected are thoroughly and patiently applied. When it is found that under the use of a remedy the patches not only cease to extend but the number of diseased hairs diminishes and the number of healthy hairs increases, the remedy which has effected this progress should be persevered in; the progress will in all probability be steady and the disease eventually be rooted out.

At the outset the patient's friends should be told that the disease is a chronic one, and that a rapid cure, although not impossible, is not to be confidently expected. After the practitioner has satisfied himself that the treatment is being properly applied, he should not, as a rule, see the patient too frequently, so as not to lead to the expectation of a speedy result. It is only in exceptional cases, or when strong remedies have been used that the patient should be frequently seen.

The remedies for ringworm may be divided into two classes --parasiticides pure and simple, and irritants, although it is to be remembered that many irritants are also parasiticides.

To an inexperienced man the choice of remedies recommended in books must be bewildering. Among others they comprise: sulphurous acid, boracic acid, hyposulphite of sodium, iodine, thymol, sulphur, tar, goa powder, chrysophanic acid, menthol, oleate of copper, salicylic acid, turpentine, and

various salts of mercury. Some of these substances are used in solution as lotions, some in ointments, and some in combination with glycerin. One practitioner has assured me that for many years he treated cases of ringworm successfully by the frequent application of mustard poultices. Not only are various methods used, but the fashion of remedies varies according to time and locality.

It will much facilitate the treatment of ringworm of the head if we can act in accordance with some general principle which is in harmony with observed clinical facts.

Ringworm of the scalp is not only curable but it is cured by very different remedies. If we examine what there is in common in the remedies that are known to be efficacious, we shall find that they all have the property of producing certain degrees of inflammation of the skin. If we also bear in mind that ringworm in rare cases effects its own rapid and complete cure, and that in these cases the inflammation is acute and leads to the rapid formation of pus, we find that what is common to the spontaneous cure and to the action of the well-known remedies is inflammatory action.

As long as the inflammation caused by Trichophyton in the hairs leads to the formation of simple scales and crusts, the disease goes on, the fungus lives and multiplies. But if from some peculiarity of the affected subject the inflammation becomes quickly purulent and extends downward to the root of the hair, the disease disappears. Inflammation, then, if carried to a certain degree of severity, destroys the fungus, and the cases of spontaneous cure in children are those in which the inflammation is sufficient in itself to lead to its destruction. In such cases permanent baldness over the affected area is the result, and the small bald spots sometimes seen on the heads of children with otherwise abundant hair are due to this cause. But in the very great majority of cases the inflammation excited by the fungus is not sufficiently acute to lead to this result.

The principle of managing the disease consists in procuring in the hair-follicles an inflammation sufficiently acute to gradually lead to the destruction of the fungus, without causing destruction of the hair-papillæ or leading to ulceration of the scalp. To do this successfully the practitioner must consider the age and constitution of the patient, and apply his

remedies tentatively at first until he discovers the degree of concentration that is suitable for the skin of the child. Age is not of itself a sufficient guide, the irritability of the scalp in different children varying very much. For this reason the patient should be seen more frequently in the early stages of the treatment than later on.

Bearing this principle in mind, we are able to understand why the list of remedies which are recommended grows continually larger. The substances that are capable in intelligent hands of effecting the necessary inflammation are practically unlimited.

In the report read by M. Besnier before the Academy of Medicine in Paris in 1884, on the "Treatment of Parasitic Affections of the Skin," more particularly on the treatment of tinea, the author remarks: "In the actual state of science we do not possess a medicinal agent capable of modifying the living cells or living organic fluids in such a way as to render them unfit for the germination of the microphyte or microbe without altering these cells and these liquids in their vitality to such a point as to compromise life locally or generally."

And with special reference to the treatment of ringworm, he says, "that the applications have no other object than that of producing in the parts affected an eliminatory irritation, and that this irritation must be set up at the proper place to the degree that is required, and in necessary measure, but by no means in a manner systematic and uniform for every patient."

My own studies and experience in the treatment of ringworm are entirely confirmatory of these remarks of M. Besnier. There is no fixed formula for every case of ringworm. If too weak the application is useless, and if too strong it may destroy hair or skin. But while every case must be treated on its own merits, there are certain recognized strengths of acknowledged remedies which are suitable for the tentative beginning of treatment, and these form a basis to start with, to be modified as experience shows is required.

In further illustration of the fact that the longest and widest experience in the treatment of ringworm leads to the greatest simplicity in practice, let me quote the remarks of M. Lailler, one of the physicians of the St. Louis Hospital in Paris, and the author of most able clinical lectures on the various forms of tinea. After an admirable exposition of the

clinicial features of the disease, M. Lailler says that "the best and most efficacious means [for treating ringworm of the scalp] is certainly epilation; but as the hair invariably breaks the epilation is incomplete, and it is in this fact that there is to be sought an explanation of the long duration of the malady. At the same time that epilation is employed to remove the hairs with the spores which infiltrate them, it is also intended to facilitate the penetration of parasiticides into the follicles. Those most employed are solutions of corrosive sublimate of different strengths: the concentration generally used varying from 1 in 300 to 1 in 1,000. Between the periods of epilating and of using lotions of corrosive sublimate, the scalp is rubbed daily with an ointment containing the yellow oxysulphate of mercury in the proportion of 1 to 30. Every day or every second day the head is washed with soap. I repeat the epilation so long as careful and frequent examinations show the presence of hairs which break. Ringworm of the scalp," he continues, "is an affection in which to arrive safely at a termination it is necessary to go slowly. After many trials and many researches we are forced to return to this method of treatment, which is after all the best and the shortest that we know. What, after epilation, gives the best results is certainly inflammation of the skin where it has been provoked by scratching, by eruptions of irritative eczema, or by other irritants."

M. Lailler goes on to say that his experiments with perchloride of iron, solutions of salt, and croton oil have been discouraging. These remedies frequently provoked an unmanageable inflammation, and occasionally left cicatrices and baldness. He adds that applications have not yet been found which with certainty will lead to a uniform degree of dermatitis compatible with the discharge of the hairs containing the fungus, and at the same time compatible with the growth of new hair.

In short, M. Lailler, after his great experience, finds that the steady application of remedies which are not supposed to act with great rapidity is better and safer than attempts to procure a speedy result by the use of strong irritants. His armamentarium will appear very limited compared with the multiplied and intricate formulæ found in the pages of many of our English books.

I have quoted the opinions of Besnier and Lailler, because their experience has been in Paris, where ringworm is common; and, what is still more important, in the St. Louis Hospital, where there is a regular service of ringworm children, and in which the facilities for the study of the disease and its treatment are unequalled.

The successful treatment of ringworm depending on the production of a cerain degree of dermatitis, and there being many ways of producing this dermatitis, a cure may in course of time be effected by very different means. Practitioners who see much of the disease have usually fallen into the habit of relying on certain remedies in the use of which experience has made them expert.

My own method of treatment is as follows: In a very young child, say a child under three years of age, after the head has been prepared for treatment in the manner I have recommended, I usually begin by applying simple sulphur ointment, in the proportion of one drachm to an ounce. If this is well borne, as is usually the case, and the disease does not yield, I increase the strength of the sulphur. With this treatment, or without it, tincture of iodine may be used more or less successfully according to the age of the child. In a very young child the hairs are not planted deeply in the scalp, and a milder treatment which is successful in ringworm of the body may not improbably succeed. In the case of a very young child sulphur cautiously and continuously applied will usually lead to a cure. If it fails after sufficient trial the remedies used for older children must be cautiously applied over a surface not too large.

For children of four or five years of age, in addition to sulphur ointment I am in the habit of prescribing a solution of carbolic acid in glycerin, beginning with a weak strength (1 in 8). If the child has a delicate skin, I combine the carbolic glycerin treatment with sulphur ointment (1 or 2 drachms to the ounce), directing that the glycerin be well rubbed into the affected parts twice daily, and half an hour afterward that the ointment be rubbed in. If these remedies produce very little irritation and the disease does not yield, the treatment used for a child of six or seven is tentatively tried. In a child of six or seven the epidermis of the scalp has usually become strong and the hairs are deeply rooted. In children of this

age and older the disease is apt to be very obstinate. It is hardly practicable to make a distinction in the strengths of the applications suitable to the different ages after seven. Some children of nine or ten have the scalp so easily irritated that they cannot bear an application which in other children of five produces little or no effect. It is at this stage that the strengths of the carbolic glycerin and of citrine ointment (when this remedy has been used) must be gradually increased. At the first sign of a suppurative inflammation or rawness, they must either be weakened, or, if the symptoms are acute, boracic ointment is substituted for a few days, until the inflammation has subsided.

I am satisfied from experience that as a rule nothing is to be gained by producing too acute an inflammation on the surface of the scalp. I have seen cases in which for weeks the surface of a patch has been raw and covered with a seropurulent discharge without the disease yielding at all. The degree of inflammation which seems best adapted to effect a safe cure is indicated by a moderate erythema which is kept up persistently for some time.

Citrine ointment, properly handled, is, I have found, one of the most reliable remedies. I have known cases cured by it with scarcely any signs of inflammation being produced. I do not believe that this was due to any so-called parasiticide effect of the ointment, but to the production of chronic congestion to a moderate extent in the tissues around the hair-follicles. The distinction between a superficial inflammation of the scalp and deeper-seated congestion of the hair-follicles, with very few signs of superficial inflammation, is always to be borne in mind. It is the latter effect which we wish to produce.

In dealing with older children, carbolic glycerin and citrine ointment may very fairly be tried persistently before changing treatment. Carbolic glycerin alone can be made effective.

For example: E. R., aged thirteen, was put under my care for disseminated ringworm of long duration. The disease was in the form of raised, red, tumid, scabby patches, varying in size from a split-pea to a threepenny piece. The patches were numerous on the back and sides of the head. He was ordered to have the places washed thoroughly once daily to remove the scabs—a part of the treatment which was very

inefficiently carried out. He was treated with carbolic glycerin alone. He began with the strength of 3½ drams of carbolic acid to the ounce of glycerin. The strength was gradually increased until it was 7 drams to the ounce. No other treatment was used. He was cured in five months. I have little doubt the cure might have been attained in a less time if the treatment had been more effectually carried out, if I had seen him more frequently, and if the carbolic glycerin had been more quickly strengthened. The applications caused a little smarting, but the treatment gave rise to no inconvenience. I have used in some instances carbolic glycerin of considerably greater strength than even in this case, but have never begun with a strong solution, and have always increased the strength tentatively and gradually.

On the other hand, citrine ointment may be used alone, and a cure be effected. The strength must again be proportioned to the age and susceptibility of the patient. In very young children, say under three, I have no experience of its use In these cases I am in the habit of using sulphur ointment in various strengths, sometimes also using simple irritants, such as tincture of iodine. In children of four or five, I begin at once with one part of the unguentum hydrargyri nitratis in six of lard or weak sulphur ointment, and continue that strength for some time, increasing it if necessary. When a large part of the scalp is affected, I think it well to treat selected portions with citrine ointment, using for the other parts a sulphur ointment of the strength of 2 or 3 drachms to the ounce, the stimulating effect of which is strengthened if necessary by the addition of half a drachm of carbonate of potassium to the ounce. In older children I have occasionally succeeded by applying undiluted citrine ointment to one or two patches, and have found that it is sometimes well borne, and sometimes that it has to be quickly withdrawn on account of the irritation which it produces.

Although I have never found salivation or any other ill effects produced by the application of citrine ointment in various strengths, yet I hesitate to apply it to a very large surface, always at first watching tentatively the result, and only increasing the strength gradually.

Usually I combine both treatments. I direct that the parts should first be wiped dry and clean with a dry cloth,

that the carbolic glycerin should be well rubbed into the affected hairs and round the margins of the patches. In half an hour the part is again wiped dry and the ointment is rubbed in firmly. This procedure is repeated twice and sometimes three times a day, according to the effect produced. I have described the use of citrine ointment because it is what I frequently use, but there is ample testimony to show that other salts of mercury, if properly handled, will obtain the same effect.

The turpeth mineral, or yellow sulphate of mercury, is used by French physicians successfully, and appears to be their favorite remedy, in the proportion of 1 in 30.

White precipitate ointment in various strengths is exceedingly useful. I have occasionally found good results from the formula of the late Mr. Startin, copied in Dr. Duhring's work on "Diseases of the Skin" (third edition, p. 620):

℞ Sulphuris sublimati, ...	3 ss.
Hydrargyri ammoniati, ...	gr. x.
Hydrargyri sulphureti nigri, . . .	gr. x.
Misce et adde	
Olei olivæ, ...	f 3 ij.
Creasoti, ...	gtt. iv.
Adipis, ...	3 vi.
M. ft. ungt.	

In a case of chronic ringworm, recently under my care, in a boy aged seven, which had resisted several of the usual remedies, and in which citrine ointment was given up by the parent on account of the pain which it caused, a cure was gradually but surely effected by the use of this ointment. It had been prescribed at an early stage of the disease, and had been given up for more painful treatment. The mother fell back on it without my knowledge, on account of its not having caused pain; she used it steadily and perseveringly, and was rewarded with a good result. In Dr. McCall Anderson's "Treatise on Diseases of the Skin" it is stated that Sir William Jenner strongly recommends an ointment composed of twenty grains of ammonio-chloride of mercury and four drams of sulphur ointment. This ointment, though likely to be efficacious, is not one which I should recommend for very young children on account of the proportion of white precipitate.

The red oxide of mercury ointment, weakened to various degrees, is recommended, and is also no doubt useful. I have no experience of its use in ringworm. The formula given by authors has a strength of six grains to the ounce.

I have latterly, particularly when I wished to avoid using a mercurial ointment, occasionally used, with the carbolic glycerin, an ointment of sulphur and carbonate of potassium (from two to three drachms of sulphur to the ounce of lard, with usually half a drachm of carbonate of potassium, sometimes increased to a drachm). This ointment well rubbedin to the head produces in some children a considerable amount of erythema with some congestion of the skin. Combined with carbolic glycerin it is as efficacious as most other remedies if perseveringly used; and where a large surface is involved has the advantage of being free from the risks of absorption.

But I have little doubt that the most potent remedy in ringworm of the scalp is a solution of perchloride of mercury, although on account of the dangers attending its use, if applied sufficiently freely and of sufficient strength, I have little experience of it. I have occasionally applied it in the weaker solution, two to three grains to the ounce, but have not found it very efficacious. I have hesitated to prescribe the stronger solutions, the use of which I could not control. It forms the basis of some, if not most, of certain popular remedies known by the name of the vendor.

Three children were once brought to me supposed to be suffering from ringworm. The eldest, a girl of about eight, had been treated by a lotion publicly sold as a cure for ringworm. I found a large part of the top of the head the seat of an intense erythema, the hairs on the erythematous patch very thin, and the ringworm quite cured. The lotion, which I was informed contained perchloride of mercury, had cured the disease, but at the expense of sacrificing, probably permanently, many of the hairs.

My friend, the late Dr. Arthur Reid, of Hankow, China, told me that several children in a family were under his care for ringworm for a considerable time in Hankow. The family went to England, where they remained a year, during which time the children were treated for ringworm by more than one specialist in London. They returned to Hankow, and Dr. Reid found the ringworm still uncured. He then treated

them with solution of perchloride of mercury and cured the disease.

The strengths usually recommended are one to three grains to the ounce; the solution being generally in a mixture of water and rectified spirit. (Some years ago, a girl who was under my care for ringworm, and in whom the disease had resisted the most thorough and persistent use of oleate of mercury, was sent to Scotland, where she got rapidly well under the care of a friend in Edinburgh. I inquired how he had effected the cure. He informed me that it was effected by a preparation formed by mixing calomel and tincture of iodine in a certain way, which he had learned from a medical man in the country to whom he had formerly been assistant.

The formula was examined by Messrs. Savory and Moore, who reported to me that the product was a strong solution of perchloride of mercury, a stronger solution than my friend would probably have used had he used it wittingly.

$$\left.\begin{matrix}Hg\\Hg\end{matrix}\right\} Cl_2 + I = \left\{\begin{matrix}HgCl_2\\HgI\end{matrix}\right\} \text{in solution in spirit partially precipitated.)}$$

If perchloride of mercury is used for ringworm at all it should, unless in very weak solution, be used only over a very small surface, and the effect carefully watched by the practitioner. Those who only see their patients at considerable intervals will probably act most wisely if they prefer other remedies. A number of years ago a fatal case was reported in the "Lancet," in which death resulted from the application to the scalp of a strong solution of perchloride of mercury in spirit. The girl, who was otherwise well, suffered from ringworm of the scalp, for which the perchloride was applied. Profuse salivation occurred, and the patient died as a direct result of mercurial poisoning. It appeared from the correspondence to which the report of the case gave rise, that similarly strong solutions had been used in other cases without any untoward result, but I am not aware that since that time authors have generally ventured to recommend the application of perchloride solution in anything like the same strength. Dr. McCall Anderson, indeed, in his "Treatise on Diseases of the Skin" (p. 494), states that he has tried the application of a piece of lint soaked in a solution of perchloride of mercury in the proportion of ten grains to the drachm of alcohol, and

kept *in situ* for a couple of minutes. He says he does not "use this much now, as there is some risk of salivation, although the bichloride when used as a vesicant seems, as a rule, to have much more of a local than a constitutional action." This is a stronger solution than was used in the fatal case to which I have alluded, and that it has been applied in a number of cases shows what may be done without harm, but is not a guarantee that grievous injury may not unexpectedly result at any time from the use of such a strong remedy. My own opinion is against the use of such powerful remedies, and I advise practitioners not to allow the inconveniences of a protracted case of ringworm to induce them to use such strong solutions of perchloride of mercury. The disease never warrants the use of remedies which involve the slightest danger to health or life.

On the whole, I believe, in ordinary cases of ringworm, with more or fewer scattered patches over the head, and probably with isolated diseased hairs, the best plan is to continue a treatment with carbolic glycerin and an ointment containing citrine, or white precipitate ointment, the strength of both glycerin and ointment being proportioned to the age and strength of skin peculiar to the patient. A little observation of each case teaches the necessary strengths. This treatment prevents the spread of the disease, and if continued for a sufficiently long time will, in the great majority of cases, effect a cure. Patience, however, is required both on the part of the parent and the practitioner. If this patience fails, what is next to be done? I advise in such a case that small selected patches be treated by some of the more vigorous methods which are warrantable when the disease is confined to one or two small spots. This leads me to consider what is the best method of treating one or two small spots.

Let us take an example. A boy of ten, attending a public school near London, was brought to me with a patch of tinea circinata on the nape of the neck. This was of course easily cured, but the gravity of the case consisted in the discovery of a small patch of ringworm of the scalp, scarcely the size of a threepenny piece, on the vertex. The boy was of course immediately removed from school, and the question was raised, as usual, how soon could he be allowed to return. The patch was repeatedly blistered with blistering fluid. For two days

after being blistered it was dressed with boracic ointment. Undiluted citrine ointment was then used twice daily. As soon as the skin had completely recovered from the effects of the blistering, the surface was blistered again. The result was a cure in less than three months, and the absence from school was limited to one term. The disease of course did not spread. Treatment of this kind, which would be severe in a very young child, or in any young person over a large surface, is really of very little moment over a small area in a strong boy of eight or ten.

Some years ago I tried the effect of simple fat. For two months two patches on the vertex of a boy, each about the size of a shilling, were kept persistently covered with a thick layer of fat. The disease did not spread at all, but it did not in the least get well. I then painted the patches repeatedly with Coster's Paste a (solution of iodine in creasote), making the applications myself. A cure was gradually effected in a comparatively short time, and no baldness followed.

Blistering acts in two ways. It acts by setting up inflammatory action in the hair-follicles, and it also acts by removing the horny layers of the epidermis, and thus increasing the irritating effect of ointments which are usually combined with it. Blisters should never be used over a large surface, nor would I use them at all in young children. Of course the effect of a mercurial ointment is increased when applied to a blistered surface, and the risks of absorption are greater. It is certain that although salivation is produced in rare cases, it is not at all a common result from mercurial ointments applied to the scalp in the strengths generally used.

There are two objects to be kept in view in treating the disease. The first, which is not difficult to attain, consists in resisting its spread. The second is to get rid of the diseased hairs, and produce a growth of healthy hairs in their place. When the stumps become fewer and the new fine hairs more numerous, we know the disease is getting well, and any treatment which produces this result should be patiently and perseveringly continued. If the disease makes no progress or if it is advisable to change the treatment, what choice is to be made among the numerous class of remedies recommended? First of all it is well that we should recognize wherein the difficulty of cure consists. If we extract one of the stumps

from a patch that has been long under treatment and put it under a microscope, we shall find that the spores are destroyed to a point which is considerably below the level of the opening of the hair-follicle. This is made still more clear if we cultivate some of these hairs on meat-gelatin, when the appearance shown in Fig. 19 is observed.

It will be seen that no growth of mycelium has taken place in the part of the stump corresponding to the upper layers of the corium, while we find mycelia growing freely from the root. This condition may be found in hairs from patches which have been many months under treatment. It is the destruction of these deep-seated spores that we are forced to attempt.

A method frequently employed by experienced men is epilation, which was introduced by Bazin and is still followed by the French school, and insisted on by many authorities in all countries. I at one time steadily tried this treatment, often practising it myself; but was disappointed with the result. The treatment was painful and irksome, and I was unable to satisfy myself that the advantages were sufficiently marked to encourage me either to practise or recommend it. Practically it does not remove all the fungus. The hair breaks and leaves within the skin the part in which the spores have not been destroyed by treatment. Even if the stump is removed entirely, the spores which are adherent to the root-sheath are not removed. I am not sure even that the alleged advantage of its permitting the remedies to enter the follicles easily is more than hypothesis. The follicle probably becomes occluded until opened up afresh by the growth from below. It is quite conceivable that the presence of the hair in the follicle may facilitate the passage of ointments between the shaft and the sheath by keeping the follicle open. Extraordinary feats have been done in the way of epilation. Dr. Bulkley relates that he and the mother of a little girl seven years old, extracted 33,850 hairs from the head of the latter. I was recently consulted in the case of a boy aged eleven, whose aunt, an active intelligent woman, assured me that in her despair at the long duration of the case she practised epilation until she had extracted every hair in the boy's head (a head which I may say contained an unusually large number of hairs). The disease was not cured by the process. Although I do not

speak encouragingly of epilation from my own experience, I am bound to emphasize the fact that the procedure is supported by the very highest authorities.

The origin of the use of spirit lotions is due to the idea that parasiticides can be made to penetrate more deeply if the

FIG. 19.—A Ringworm Hair, after Long Treatment, Cultivated on Meat-Gelatin, Showing the Depth to which the Spores had been Destroyed or Sterilized. At the root of the hair mycelium is seen growing freely. *a*, Point of exit from the scalp; *b*, Trichophyton developing from the root.

fatty matters of the hair-follicles are dissolved. Dr. Cavafy has advised a solution of boracic acid, twenty grains to the ounce of alcohol, to which a drachm of ether is added. The solution is firmly rubbed into the part three times a day, the whole head being washed every morning with soap and warm water—a method of treatment also commended by Mr. Alder

Smith. Alcoholic and ethereal solutions of carbolic and salicylic acids had been previously recommended by Kaposi, but, as Dr. Cavafy remarks, these substances are much more irritating than boracic acid. I have little doubt that when a good result is obtained by these solutions, the result is due to the alcohol. Carbolic acid, and salicylic acid in alcoholic solution are so powerful, unless in very small proportions, that there is no doubt that they can in this medium be so used as to have a decided effect. But with the weak solutions in which it would be alone safe to employ them, the result must, I think, be set down mostly to the action of the spirit. Alcohol well rubbed into the parts three times a day will cause a certain amount of congestion, and an addition of boracic acid in any case cannot hurt. The treatment is a clean one, and although it is hardly conceivable that the boracic acid can be carried down to the root of a hair such as is shown in Fig. 19, the requisite degree of persistent congestion of the follicle may be attained by this means.

Oleate of mercury was so strongly recommended by some authors a few years ago, that the highest hopes regarding it seemed justified. One author wrote stating that he had cured forty cases with an ointment of 10-per-cent oleate of mercury with ½ acetic ether. I gave the remedy a fair trial, and came to the conclusion that, while undoubtedly a useful agent, it had no advantages over the older treatments by mercurial ointments. Like Dr. Bulkley, I have seen considerable inflammation caused by it without the disease being cured. Mr. Alder Smith has spoken highly of it; his formula is:

℞ Hydrargyri oleatis (Dr. Shoemaker's), ℥ ss. ad ℥ i.
Adipis benzoati, ... ℥ v.
M. ft. ungt.

Oleate of copper has been recommended by Dr. Le Sieur Weir. It is used in the strength of 1 to 6 drachms in an ounce of vaseline. As it sometimes causes a good deal of irritation it is best to begin with a weaker strength. I am not aware that the brilliant results claimed by Dr. Weir have been confirmed by subsequent observers, but there is no doubt that oleate of copper may take its place among the other irritants which may be successfully used in ringworm of the scalp. Dr. Shoemaker also recommends it, and deprecates the use of water to

the affected parts while it is being used. Mr. Alder Smith states that he has been pleased with the results which he has obtained from it. Dr. Liveing[3] reports that it was fairly tried for twelve months in nearly all the patients who presented themselves in the out-patients' department in the Middlesex Hospital (over one hundred cases); and that the results did not come up to his expectations. The use of copper (for example, rubbing with a penny which had been soaking in vinegar) is an old-fashioned remedy. The following incident occurred in my practice:

I was treating a boy very successfully with carbolic glycerin and an ointment of sulphur and carbonate of potassium. The number of diseased hairs at each fortnightly consultation was steadily diminishing, and I was well satisfied with the result. The parents were, however, very impatient to be able to send the boy back to school, and the nurse, at her own instance, expedited matters. She put half a pound of sulphate of copper in a pint of vinegar. After a few days she took the crust which had formed on the sulphate of copper and rubbed it firmly into the affected parts. The result was that the few remaining diseased hairs disappeared, but the treatment had produced rather a violent erythematous inflammation, an inflammation considerably more intense in degree than had been produced by my remedies. When I saw the boy I found the skin very red and fiery, although the inflammation was stated to have abated considerably. However, the case remained well.

Tar has long been used in ringworm, and as it has a special power of penetrating hair-follicles and exciting inflammation in them, one would *a priori* have expected striking results from its use. It cannot, however, any more than other remedies, be considered specific. A solution of iodine and tar (Coster's paste) has often been found useful, the formula being: Iodi, ʒ ij.; olei picis liq., ad ʒ i. After the scab which the application produces can be removed, the remedy may be applied again.

Undiluted huile de cade (oleum cadini) may be painted on the patch, or it may be incorporated with an ointment. If any good is to be expected from this treatment it must be applied frequently, and followed up persistently.

Iodine. While in very young children tincture of iodine will sometimes cure the disease as readily as it cures tinea

circinata, and for the same reason, namely, because the hair-follicles are not deep, in older children it usually disappoints. I have known not only tincture of iodine but linimentum iodi repeatedly used without effect. It belongs to the class of remedies which produce considerable superficial inflammation without exciting irritation at the root of the follicles.

Chrysophanic acid and Goa powder. The strikingly good effects produced in ringworm of the body, and more particularly in inguinal tinea, by Goa powder, led to extravagant expectations from its use in ringworm of the scalp. These expectations have not been fulfilled, although, from its power of producing cutaneous congestion, it can undoubtedly be used in such a manner as to cure some cases of ringworm. Yet it often fails, and it has the great disadvantage of producing an erythema that occasionally spreads over the face and neck, causing great alarm to the patient's relatives, as well as to the practitioner. In whichever way it is used, whether as mixed with chloroform or in the form of an ointment, I do not think its superiority to other remedies outweighs its disadvantages. Mr. Alder Smith prefers the Bombay Goa powder to ordinary Goa powder or chrysophanic acid, and considers that in certain cases it is worth a trial. I have seen so much alarm produced by its use, that I never prescribe it.

Boracic acid, thymol, iodoform, eucalyptus, are remedies which, being antiseptics, have been tried and more or less recommended. An antiseptic, as such, is useless in ringworm of the scalp; and these and other antiseptics are only useful in so far as they are combined with other substances which stimulate the blood-vessels.

Salicylic acid in ointment (½ drachm to 1 drachm to the ounce) or in oil, still more in spirituous solution, may be made to have a very stimulating effect on the scalp, and in some cases the ointment is convenient and leads to good results.

Turpentine has been used in treatment of ringworm of the scalp. It can of course be so used as to produce inflammation enough to cure the disease, but I do not think that can be conveniently done. I do not consider it one of the manageable remedies.

Pyroligneous acid and ordinary strong acetic acid are old remedies for ringworm, being used on the principle of "stamping out" the disease. No doubt they can be used in such a

manner as to succeed. But there is no reason to suppose that they have any advantage over other strong local irritants. If used at all they must be used over a limited surface, and their action confined to the part directly affected. They should be painted lightly in the same manner as blistering fluid, and the part subsequently treated as if it had been blistered. The best that can be said for this treatment is that if cautiously employed it is not likely to cause baldness. But the chances of its promptly cutting short the disease are very small indeed. If vesicants are used at all, I prefer liquor epispasticus. M. Monlque,[4] whose observations were made in the service of Lailler, states that pyroligneous acid is useful, and does not produce baldness, while M. Thomas,[5] relying on twenty-six observations of cases, states that it may cure, but that its action is not constant, and that it may produce accidents such as dermatitis and alopecia, like croton oil and other strong topical remedies.

Croton oil has been long used in France, where, after having been thoroughly tried, it has been condemned by the best authorities. Dr. Ladreit de Lacharrière manufactured pencils containing croton oil, suitable for rubbing over the affected parts. Croton oil produces an intense and often a suppurative inflammation of the hair follicles, which there is no doubt frequently produces a cure, but by no means quickly, and certainly not always. This procedure, after being tried experimentally at the St. Louis Hospital, was rejected as inefficacious and dangerous. It was considered dangerous because the suppuration of the hair-follicles might determine permanent baldness, and inefficacious because recurrences of the disease were observed in patients treated by Dr. Ladreit de Lacharrière himself and discharged as cured. M. Cadet stated that by croton oil he obtained twenty-one cures in thirty-two cases; the extreme duration of treatment was eleven months, but in seventeen cases it did not exceed six. In three cases it caused permanent baldness. The average duration of treatment was three months. M. Massey states that erysipelas followed the croton-oil treatment in an average of four cases out of a thousand. All the advocates of croton oil recommend that it should be applied very cautiously, sparingly, and over a limited surface, and followed by poulticing. The application of the oil should be repeated according to circumstances, the

object being to produce artificial kerion. I do not enter further into particulars regarding its use, because I disapprove of the treatment altogether. I have seen in my own practice the treatment successful in curing an old-standing and obstinate small patch, but I have also in my own practice seen a bald patch twice produced and permanent disfigurement caused in consequence. I do not consider that the advantages claimed by the most enthusiastic advocates of the treatment would counterbalance the risks of such a result. I strongly dissuade any practitioner from using croton oil in ringworm. It may be urged that baldness is a result of want of expertness. It may be so, but where the personal equation comes in so strongly, I do not advise any one to be so self-confident as to believe that he can exclude risk.

A treatment analogous in principle to that of blistering and the use of mercurial ointments has been recommended by Mr. Harrison, of Clifton. Mr. Harrison softens the epidermic structures by a solution of potash and then applies a solution of perchloride of mercury, and claims great success from the treatment. He mixes liquor potassæ and spirits of wine in equal proportions, and adds half a drachm of iodide of potassium to the ounce of the mixed solution; this he calls his No. 1 solution, which he states must not be applied to the scalp for more than a few minutes. He dabs on the solution with a pledget of lint soaked in it, and applies it to the scalp for three or four minutes at a time. When this has been done two or three times at intervals of two or three days he uses what he calls his No. 2 solution and applies it for the first time in ten minutes after using the No. 1, and then re-applies his No. 2 two or three times at two days' intervals. His No. 2 solution is made by dissolving four grains of mercuric chloride in equal parts of spirits of wine and water to make an ounce. After having applied the two solutions he waits a few days without using any remedy, unless it be a little cacao-butter to facilitate the removal of any scabs which may have formed, and then commences the treatment over again with this difference, that he now applies the potash solution once and follows it up with a mercuric one, very often using both at the same sitting with an interval of ten minutes between. The hairs are kept short. In severe cases the scalp must be divided into sections.[6] The treatment is likely *a priori* to be a successful one, com-

bining as it does the action of two powerful irritants, and by softening the superficial layers of the epidermis increasing the susceptibility of the skin to the perchloride. I do not maintain that skilfully managed this treatment cannot be used without risk, but there are so many elements which enter into the successful use of such a powerful remedy that, for my own part, I should not use it unless over a surface so small that permanent baldness would be of no consequence.

I was recently consulted in the case of a boy in whom an inveterate ringworm had long resisted treatment. I found a bald patch on the back of the head about an inch square, which had resulted from the treatment recommended by Mr. Harrison, while the disease had not been cured in the other parts of the head. In this case at least no exception could be taken to the administrators. The boy was under the care of an experienced physician and a trained nurse. Like the treatment by croton oil, the combined treatment by solution of potash and perchloride of mercury is a method that, however successful it might be in a large number of cases, I would neither use nor recommend, as it is not free from the risks of excessive dermatitis and partial baldness.

Electrolysis has been suggested by Mr. Alder Smith for the removal of isolated stumps. It is likely to be useful in cases where only a small number of hairs are affected, and where it is desirable, in order, for example, to enable a boy to return or get admission into a school, that he should be rapidly placed above suspicion. The sensation caused by the operation is so disagreeable that I have known it impossible to persuade a boy of seven to submit to it; but with older boys it is more practicable. Electrolysis gets rid of the diseased hair by destroying the hair altogether. The hair will never be replaced. It is evident then that it can only be applicable to a very few hairs and therefore in very few cases. The operation in itself is not difficult, only a little practice being required. I have used it repeatedly for the destruction of hair in adults. Even a nervous woman will remain perfectly quiet during the process. The scar that is left is so slight that it is barely perceivable on close scrutiny; and if the action of the electrolysis is not carried to an unnecessary degree, scarcely any scarring is left at all.

I employ a Stoehrer's battery, using from ten to fifteen or

sixteen cells according to the effect, the time occupied in destroying the hair being from twenty to sixty seconds. The average time is thirty to forty-five seconds. This is an operation in which practitioners may acquire the requisite dexterity with very little practice. The first attempts should hardly be made on a patient under treatment. Those who are not familiar with the use of electrolysis may study its effects in the web of the foot or in the eye of a newly-killed frog. Its action on hairs may then be easily practised on the operator's own arm, and the experiment requires no great courage or endurance. I use an iridio-platinum needle. This operation, for which we have to thank the ingenuity of our American cousins, is rapidly passing into general use, and is the only method suitable for the destruction of the hairs, which on the upper lip, chin, and sometimes the thorax of sensitive women, are the cause of so much misery.

When from [illegible] the child or from any other reason, electrolysis is not available for the removal of isolated stumps, the best treatment (for as my own experience shows) is to [illegible] hair-follicles repeatedly with a drop of [illegible] rubbing between the intervals of blistering [illegible] two days, a small quantity of citrine ointment [illegible] dressing after the blister being boracic-

[illegible] has arisen as to whether it is wise to wash the [illegible] suffering from ringworm, the fear being that [illegible] the spores may be carried over the head. I [illegible] this occur, and am of opinion that washing [illegible] with soap and water is good, more particularly [illegible] with soft soap. I believe that washing with soft [illegible] itself an effective remedy, and it certainly facilitates [illegible] of other remedies which are applied.

Does ringworm of the scalp ever get well spontaneously? This is a question which I do not think can in the strict sense be answered decisively. We know that the disease may last [illegible] years, and that it gets well spontaneously at puberty; but I am not aware of recorded facts which prove definitely that it undergoes spontaneous cure. At the same time I am disposed to believe that it does so, and it is quite possible that many of the recoveries attributed to methods of treatment are really due to the fact that the remedies prevent the ex-

tension of the disease to unaffected hairs, and that the fungus, having exhausted the soil, or altered its soil, eventually succumbs. The question is well worthy of careful study and observation, and it seems to me that some of the remarks made by the distinguished French physicians, whose words I have translated in an Appendix, are specially suggestive in this direction.

APPENDIX.

ON THE FRENCH TREATMENT OF RINGWORM OF THE SCALP.

Through the kindness of M. Vidal I am able to give an account of the treatment pursued by M. Vidal, M. Lailler, and M. Besnier, physicians to the Hôpital St. Louis, Paris.

These gentlemen have acquired their experience at the St. Louis Hospital, where, since the days of Bazin, unceasing attention has been given to the nature and treatment of the various forms of tinea, the frequency of the disease in Paris being such as always to insure the attendance of a number of patients in the wards and in the out-patient departments. I consider it a privilege to be able to present to English readers a translation of the letters sent to me by M. Vidal.

M. Vidal states that: "In tinea tonsurans I employed for a long time the treatment of Bazin, which is that followed in the out-patients' department of the hospital, and which consists, as you know, in epilation, application of a solution of perchloride of mercury (1 in 500) and ointment of turpeth mineral (1 in 60). Average duration ten to fifteen months. I have tried extensively the treatments without epilation and the treatment of Cramoisy. I soon gave up using the pencils of croton oil, the folliculitis which they caused, with cicatrices and destruction of the hair in the suppurating follicles, producing baldness. The method is one of epilation by inflammation, or destruction of the cryptogam by pus, as in kerion. In some cases very small patches can be thus cured in three to four months, but relapses are frequent even when turpeth-ointment is employed at the same time. I have tried oxygenated water with an apparent amelioration but without definite results. The disease reappeared as soon as I ceased the treatment. I have tried a modified form of the treatment with essence of turpentine, then tincture of iodine, then an ointment

of carbolic acid, but a cure did not follow in six weeks as the originator of the method said would be the case; a cure was not effected even in three months. I gave up the treatment. I have tried iodine vapor either in the first instance or after having decolorized the hair by means of oygenated water. I hoped to cause the iodine vapor to penetrate the hair-follicles. I used iodized wadding, after having the head shaved, applying it to the skin so as to avoid too irritating an action. I obtained in this way rapid amelioration and appearances of cure, but after six weeks to two months' cessation of the treatment the disease reappeared. I have tried, without result, preparations of glycerin with calomel or even with perchloride of mercury.

"For the last four years, while continuing my experiments on treatment without epilation, I have tried a treatment by simple fats, renewed twice a day. I have tried lard and butter; now I am using vaseline. Without entering into the details of all the modifications which I have made, the method which I employ at present is the following: The hairs are cut very short, as short as they can be cut with scissors; I rub the scalp with essence of turpentine, then I paint with tincture of iodine (with the object of destroying the parasites which are situated in the epidermis). The following day the whole head is covered with a coat of vaseline, then a thin india-rubber cap is put on, or a cap of bladder, or a very thin sheet of gutta-percha. Morning and evening the dressing is renewed; the head, and the cap which is used as a covering, being carefully wiped. I have obtained by this treatment cures in five or six months, and after three months one might imagine in some cases there was an actual cure. But it is difficult to secure that a treatment which demands so much care and attention is followed very conscientiously. I only prescribe it in my private practice and in my wards in the hospital under my own eye. For the out-patients I prescribe it rarely, and only when I have reason to hope that they will be cared for by intelligent people who will make the two applications daily.

"The hypothesis on which this treatment is founded is the following: It removes the parasite in proportion as it arrives on the surface of the skin and prevents its propagation. The hairs infiltrated with spores, which having broken could not

be extracted, have time to be loosened and eliminated. Further, Trichophyton, being a fungus that requires air, is placed in unfavorable conditions, the layer of vaseline and the impermeable cap preventing its coming into contact with the air; it thus lives in a medium in which it does not find the quantity of oxygen necessary to its vitality. For the other patients in my policlinique, and also for those who having commenced the treatment have not carried it out regularly, I follow the treatment of Bazin—epilation, lotions of corrosive sublimate, and application of turpeth-ointment. This is also the treatment used by Dr. Fournier in his wards and in his policlinique."

M. Lailler writes: "The treatment which I employ at present is the following: Epilation repeated once in three weeks or once a month according to indications. Morning and evening frictions with linen soaked in the following solution:

"Water, ... O ij.
Glycerin, ... f 3 x.
Perchloride of mercury,
Chloride of ammonium, . . . āā gr. xv.

"After the friction has been made, the head is covered with a linen cloth which has been used for the purpose before, and above that is worn a cloth cap. This is perhaps the least bad of all the treatments I have tried. I now only wash the head once a week. The mean duration of treatment is twelve to fifteen months."

M. Besnier states that he "practises epilation of the healthy hairs which surround all the patches, or all the suspicious points, and keeps this zone epilated during the whole period of treatment. (It is quite exceptional to find that the disease spreads from one hair to another beyond the line of circumvallation made by the epilation, when this epilation is really carried out among the healthy hairs during the whole period of treatment.) The head is washed every morning with warm water in which boracic acid is dissolved, in the strength of 5 in 1,000, and soap is added if the state of the head permits it. Every evening an ointment is lightly rubbed in composed of vaseline with a very minute quantity of sulphate of copper (from 0.05 to 1 per 1,000), the friction being managed in such a way as never to cause dermatitis.

"This condition is to be considered absolute, and if the skin of the patient is irritable, and if there are eczematous points, whether caused by the fungus or not, I limit myself to rubbing in a pomade of vaseline, or of fresh butter with 5 per cent or even less of boracic acid. The lotions and ointments have no other object than to sterilize the healthy hairs and to render them unfit for the growth of Trichophyton. Ringworm patches, once isolated by the line of epilation, cure spontaneously after a few months. No medicinal substance can destroy Trichophyton without exciting a dermatitis in the hair-follicle to a dangerous extent.

"There does not exist any parasiticide, properly so-called, for the parasitic fungi of the skin. For patients who have a delicate sin all irritants are hurtful. In those who have not this peculiarity, the elimination of the affected hairs is favored by local applications of tincture of iodine or of tincture of iodine mixed with chloroform or with strong acetic acid, repeated according to the effect produced.

"The applications ought to be made and their effect watched by the medical man himself.

"I possess notes of the cases of a great number of patients treated elsewhere by irritants who bear the indelible traces of the unhappy intervention of the medical man, and this in an affection in which a spontaneous cure is an absolute rule.

"The duration of tinea tonsurans is always long — from two months to two years. I do not admit as cures cases in which the cure is not established by the microscope. Nine-tenths of the patients whom medical men send back to school as cured are not really cured, as the microscope shows, and this is an essential cause of the propagation of the disease. To resume, I make no pretension in my treatment to destroy Trichophyton once developed in the hair-follicle.

"I only seek to limit its extension by isolating the patch or patches by means of epilation, to sterilize the parts not yet affected by preserving them from every cause of irritation, and from all traumatism which favors extension by auto-inoculation and by using the lotions or ointments either simple or slightly impregnated with copper, which I consider best adapted to sterilize hairs against the growth of Trichophyton."

CHAPTER IV.

TINEA CIRCINATA (RINGWORM OF THE BODY).

TINEA CIRCINATA is a superficial inflammation of the skin produced by the growth of Trichophyton in the horny layers of the epidermis and in the shallow follicles of the fine lanugo hairs.

The chief characteristics of this inflammation are its superficial character and its tendency to assume a marginated circular form. The degree of the inflammation and the progress of the eruption are not uniform. In young persons or in persons with delicate skins it spreads quickly. In persons with hard dry skins it is very probable that it is not capable of developing at all.

The most common seats are the face, neck, more particularly the back of the neck, fore-arms, and back of the hands; that is to say, in parts apt to be infected by spores from the head when ringworm exists there, or from contact with affected animals, or children. Nurses, or attendants on young animals which are affected (such as calves and young horses), get the disease on their fore-arms.

The eruption begins in an erythematous spot which very soon shows scales. The spot extends as a ring, and on the margin of the ring the scaling is usually more marked than in the centre. The inflammation is therefore more acute on the margin, the soil last infected, a kind of tolerance being established in the centre of the spot. There is always an attempt at the formation of vesicles; that is, vesicles are usually found in the margin, and their size and number indicate the degree of inflammation. Sometimes they are exceedingly small, and when they give way show no appreciable fluid. At other times they are so large, full, and numerous, that they form a raised abrupt ring, from any part of which fluid exudes when it is pricked. In rare cases the appearance of successive

rings can be detected, one within the other; but this is not very common. The size of the rings, as they usually come under observation, is generally from a sixpence to a florin, but the rings are often well marked when not larger than a split pea. There is really no definite limit to the extension. The coalescence of two or more rings produces patches of a gyrate or festooned appearance.

The detection of ringworm on the neck or face of a child should at once lead to a careful examination of the head, where the source of infection will usually be found. Unlike ringworm of the scalp, ringworm of the body occurs in adults as well as in children.

The fitness of the soil for the development of this disease varies in different individuals, and in different parts of the body of the same individual, which is probably the reason why we rarely find the patches extending beyond a moderate size. The growth of the fungus seem in most instances to come to a stop; and after a time appears to wear out the soil, and to gradually cease from want of nourishment.

The detection of the fungus is very much more difficult than in ringworm of the scalp, and sometimes requires considerable perseverance. It is most readily found in the scales of the periphery. The method of examining the scales is the same as that for the hairs. The mycelial nature of the fungus, however, is in this case evident.

The disease has been experimentally inoculated by several observers, among whom Dr. Edward Wigglesworth may be cited. Dr. Wigglesworth[7] reports that a gentleman inoculated his arm with hairs and scales from the head of a child on December 18th, 1873. On January 25th there was a circle of tinea circinata as large as a silver "half-dime." On February 8th everything had returned to its normal condition without treatment. Another gentleman on October 5th, 1877, inoculated the flexor surface of the left arm with scales from a case of tinea tonsurans and tinea circinata. On October 16th the patch had extended to 1 cm. in diameter, the border being slightly raised into a papule. On November 3d the patch was 3 by 3½ cm., the appearance being that of a typical ringworm, and the microscope showing spores of mycelium.

Diagnosis.—The diagnosis is usually not difficult. The want of symmetry and the localization, the eruption being

present usually on one part of the body only, are the leading points. These features, with its abrupt border, distinguish it from a simple scaly eczema. When occurring on the back of the hand it is distinguished from herpes circinatus by its being limited to one side. There is a stage when the spot resembles a patch of an acute eruption of psoriasis; but the limitation to one part distinguishes it. In a few days the thin fine scales in the centre have assumed a different aspect from the heavier and more imbricated scales of psoriasis.

The only form of syphilis with which it could be confounded

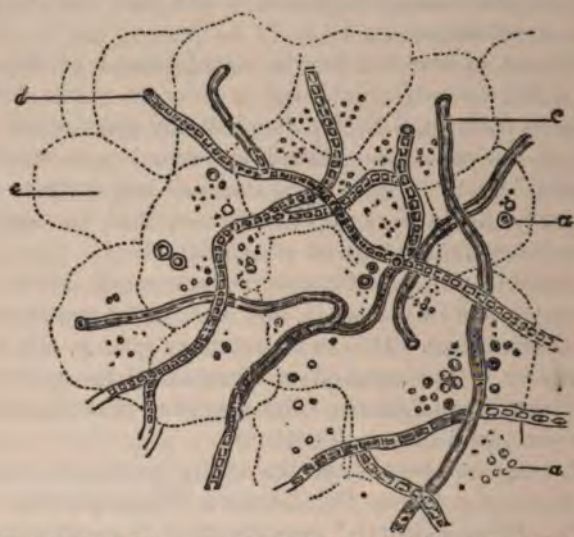

FIG. 20.—Trichophyton Tonsurans, as seen in Scales from Tinea Circinata (copied from Cornil and Ranvier's "Manuel d'histologic pathologique."

is the stage of secondary eruption, but the secondary syphilitic eruption which it might resemble is generally a syphilitic roseola, and does not scale, and in syphilis the distribution is more general over the body.

The yellow cups of favus, and the brown desquamating cuticle, without redness and without vesicles, of tinea versicolor, with the large affected surface or number of patches peculiar to the latter disease, are sufficient to distinguish them from ringworm of the body. Indeed, the only two diseases with which I can imagine its being easily confounded are eczema and herpes circinatus; and when the characteristic features

which have been described are not sufficient to establish the diagnosis, a patient search with the microscope will, if the disease is parasitic, demonstrate the presence of Trichophyton. The itching usually present, more or less, varies so much that the symptom is hardly available in making the diagnosis.

Treatment.—The treatment of body ringworm is usually as satisfactory as that of the head is troublesome.

If the patch is painted once or twice with tincture of iodine, and well scrubbed with soft soap, the disease is cured. To make sure, the patient may be ordered a white precipitate ointment to be rubbed in once a day.

M. Vidal writes me that since 1861 he has preferred, to all other treatment which he has tried, painting with tincture of iodine. He applies iodine over a space extending three-eighths of an inch beyond the ring every morning for three days, then applies it twice afterward at intervals of two days. He finds two applications usually sufficient. If any irritation is caused he applies it after an interval of two days.

M. Besnier adopts a somewhat similar plan. He rubs the patch very firmly with cotton which has been soaked in tincture of iodine, applying this treatment both in the erythematous and in the vesicular form. He usually finds one application sufficient. A second friction is necessary when the peripheral zone has not been treated sufficiently actively.

CHAPTER V.

INGUINAL RINGWORM (ECZEMA MARGINATUM).

This form of ringworm is so different from the two others, that it was first described by Hebra as a form of eczema under the name of eczema marginatum. The term marginatum calls attention to a diagnostic point between the parasitic and a simple eczema.

Koebner first showed that the disease is due to Trichophyton.

The tender skin of the inguinal region, and the moisture of the parts, favor the development of the fungus. Starting from the scroto-crural fold, the disease advances over the inner aspect of the thighs, and extends backward over the gluteal regions. The large rings sometimes meet in the lower part of the lumbar regions, but usually do not extend so far, the affection limiting itself to the moist skin of the inner aspect of the thighs. The affected surface is more or less red, sometimes very little so, and slightly scaly. The margin is abrupt, raised, and much more scaly than the centre. As in ordinary ringworm of the body, sometimes traces of previous margins are observed within the outer one.

The disease is very common in certain tropical countries, where it is usually known by a special name for each locality. Thus we hear of "Chinese ringworm," or "Burmese ringworm," etc. As it is supposed to be, and probably is, conveyed by native washermen wearing drawers which have been sent to wash, it is also known in these countries as "Washerman's itch," "Dhobie's itch," etc. It sometimes causes considerable itchiness and irritation, and may last for many years; and, unlike ordinary ringworm of the body, is very rebellious to remedies.

In these respects it differs from ordinary ringworm of the body. It is also noteworthy that it is never endemic among

a group of persons, as in a family or school, and is practically not contagious. The diagnosis is easy, and consists in the association of the abrupt raised margin of tinea circinata with the irritation, desquamation, and vesicles of eczema.

The treatment consists in the frequent and firm application of certain irritants. I am in the habit of prescribing washing with soft soap twice daily, and rubbing in Wilkinson's ointment, as modified by Hebra.

℞ Sulphuris sublimati,
Olei cadini, ... āā ʒ iv.
Saponis viridis,
Adipis, ... āā ℥ i.
Cretæ præparatæ, ... ʒ iiss.
M. ft. ungt.

This treatment is somewhat painful, but any treatment that is effectual in this disease must stimulate with some severity.

Kaposi recommends the application of a 1-per-cent solution of naphthol in alcohol and a 5-per-cent naphthol ointment. Tar, iodine, solutions of perchloride of mercury, are all used more or less by practitioners, tincture of iodine, perhaps, more frequently than the others.

In obstinate cases the epidermis must be softened by applications of soft soap, which are allowed to remain for some time on the skin. This treatment is, however, severe, and not to be begun in the first instance. After the malady is cured, the inguinal fold must be carefully kept dry, powder being freely used.

CHAPTER VI.

PARASITIC SYCOSIS.

When Trichophyton attacks the hairs of the beard it produces a disease known as parasitic sycosis. This affection, although it occurs occasionally, is not common in England. It has been most frequently observed in Paris, where, however, it is getting more rare. The affection is supposed to be usually conveyed by the razor of the barber.

Lailler describes two degrees of it. In one, which he terms pityriasis alba parasitica, the affection does not penetrate more deeply than the openings of the hair follicles, producing a very slight desquamation, and causing the formation of a sheath round the hairs, giving the well-known aspect of goose-skin.

The disease frequently spreads to the non-hairy parts, where it acquires the characters of ordinary tinea circinata. In the second degree the parasite penetrates the hair-follicle, and each hair becomes the centre of a zone of inflammation. The cutis becomes congested, inflamed, and tuberculated; pus forms, the hairs loosen and are easily extracted. The inflammation may be so intense as to produce the aspect of a conglomeration of boils.

Diagnosis.—The quick rate of development, and the absence of cicatrices, distinguish it in the erythematous stage from lupus erythematosus.

The bright color, and the absence of itchiness and desquamation prevent the disease being confounded with syphilis.

The limitation to the hairs distinguishes it from eczema, which, even when it exudes and is purulent, is still not tubercular.

The diagnosis between parasitic and non-parasitic sycosis may present some difficulty. The parasitic sycosis develops much more quickly, non-parasitic sycosis being an essentially

chronic disease. The parasitic disease is often associated with erythematous desquamating circles, and produces more exuberant mushroom-like tubercles than the non-parasitic affection. Examination of the hairs and the presence or absence of Trichophyton will remove all doubts.

Treatment.—Kaposi recommends painting the part with a 1-per-cent solution of perchloride of mercury, or the use of a soap composed of naphthol, sulphur, and alcohol, or the application of acetic acid, with the addition of dry sulphur immediately afterward, stating that this treatment often renders epilation unnecessary.

Lailler, on the other hand, recommends epilation as soon as the inflammation has attained the stage of sycosis, parasiticide lotions in the early stages, and daily shaving of the affected part.

CHAPTER VII.

TINEA TRICHOPHYTINA UNGUIUM ONYCHOMYCOSIS TONSURANS.

The ringworm-fungus occasionally attacks the nails, sometimes being found at the same time on other parts of the body. It may occur in the nails of both fingers and toes, but it is usually only present in those of the fingers.

There is nothing distinctive in the degeneration of the nail substance caused by the fungus, and it would be impossible without the microscope to distinguish the disease say from psoriasis of the nails. Eczema and lichen ruber, when they affect the nails, produce similar appearances.

The nail is brittle, opaque, laminated, thickened, and soft, particularly at its free border, under which the mass, more or less thick, of softened broken-down nail-substance can be seen. Some of this substance examined in a solution of potash shows the presence of Trichophyton.

The affection is particularly obstinate, it being very difficult to get remedies to reach all the affected parts. The nail should be scraped very thin and, if necessary, liquor potassæ applied with a brush to soften it. When that is done creasote or acetic acid may be dabbed over the part, or better still a solution of perchloride of mercury (two to five grains to an ounce, dissolved in alcohol and water, applied twice or thrice daily. Whatever treatment is adopted must be carried out carefully and persistently.

CHAPTER VIII.

KERION.

In the fifth book of Celsus there is a description of a skin disease which he calls kerion. One variety of the disease has the appearance of a large painful boil, and shows, when it is ripe, a great number of openings through which a gelatinous purulent fluid trickles, although this does not lead to the disappearance of the swelling. There is more decayed matter, he states, than in a boil, and the swelling occupies more space. It is nearly always found on hairy places.

Celsus distinguishes a second kind in which the affected area is somewhat smaller, but in which the surface is more "ulcerated." Otherwise there is no difference to be found in his description of the two forms.

The kerion of Celsus is thus a swelling which occurs on the hairy scalp, pale red in color, honeycomb-looking in appearance, soft, and with many gaping openings corresponding to the hair-follicles, from which there flows a viscid bird-lime-like fluid. The swelling does not suppurate, but the hairs fall out with or without their sheaths. Sometimes, especially at the beginning, there is pain, and even fever. The cervical glands on the corresponding side are swollen.

In 1866, Tilbury Fox showed that the disease is caused by Trichophyton tonsurans. The disease is not common, but when once seen the appearance is so characteristic that it can always afterward be easily recognized; indeed it is so unlike anything else that occurs on the scalp that it can hardly be difficult to recognize it from the description alone.

Dr. Tilbury Fox states that its characters are: (*a*) general prominence of the patch; (*b*) its perforation with foramina, *i.e.*, the mouths of the hair-follicles; (*c*) the outpouring of a mucoid fluid; (*d*) the non-suppuration of the swelling; (*e*) the looseness of the hairs; (*f*) the after-baldness; (*g*) the presence of a fungus in the hair and follicles.

Although Trichophyton is found in some hairs, yet many hairs from a patch may be examined without finding any fungus. The disease is evidently due to unusual susceptibility on the part of the individual to the poisonous action of Trichophyton.

Treatment consists in extracting all the hairs and in applying a weak solution of corrosive sublimate or carbolic acid lotion.

CHAPTER IX.

TINEA IMBRICATA.

DR. MANSON has described a parasitic disease of the skin which he considers has been hitherto confounded with tinea circinata. He describes it under the name of tinea imbricata, and states that if it has been in existence any length of time it involves a very large surface, such as an entire limb or side of the trunk, or oftener still, if not checked, nearly the whole surface of the body. It is characterized by the abundant formation of scales, successive waves of which are imbricated over each other. It excites very little irritation, and contains the fungus in profusion.

Manson distinguishes it from tinea circinata by the extent of surface involved, the absence of irritation, the imbrication and the profusion of fungus; the amount of fungus in tinea circinata being usually not great. He also states that he has succeeded in inoculating tinea imbricata and tinea circinata on different parts of the same individual, and that in the result of the two inoculations the characteristic differences were maintained.

Dr. Manson was kind enough to send me a bottleful of scales from a case of tinea imbricata. These scales are formed by small thin flakes, and certainly it would be difficult to have filled a bottle with similar flakes from such cases of tinea circinata as we are accustomed to see in England. Manson observed the disease in Amoy, but states that all his patients, with one exception, had been at one time in the Straits of Malacca or the islands of the Malay Archipelago; and he believes that tinea imbricata is the same as the disease described as pita or Tokelau itch.

In examining the scales referred to under the microscope, I found that they contained various fungi. There was a considerable proportion of mycelia and conidia indistinguishable from the mycelia and conidia of Trichophyton. But there were

also mycelia of a totally different aspect, some being smaller and some larger than Trichophyton. The engraving (Fig. 21)

FIG. 21.—Fungus Found in Scales from a Case of Tinea Imbricata, sent to the author by Dr. Manson. *b*, Spores, and *d*, mycelium, microscopically indistinguishable from the spores and mycelium of Trichophyton tonsurans; *c*, mycelium of fungi which, from their comparative size, cannot be Trichophyton tonsurans. *b*, *c*, and *d* are drawn by camera to the same scale.

represents the appearances of the fungi seen among these scales.

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NOTES ON

DENTAL SURGERY

INTENDED FOR

Students of Medicine and Medical Practitioners.

BY

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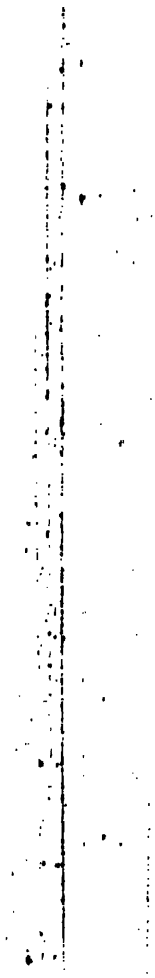

NOTES ON DENTAL SURGERY.

CHAPTER I.

THE following pages are intended for students of medicine and medical practitioners, as an abridgment of the elementary principles of dental surgery, with as much practical information as might enable some of the more common operations in that department to be performed, if not with the artistic skill of the expert, at least in a manner that in many emergencies would be satisfactory and beneficial.

The importance of a larger provision being made for the treatment of dental diseases has of late occupied a considerable amount of attention. Whether the supply of specialists in this line, or the increased institution of public dental appointments may yet meet the exigencies of the occasion, is difficult to foresee, but there seems little doubt that an acquaintance with the subject by medical men, in a greater measure than at present prevails, might be of considerable advantage.

The chapters are arranged somewhat in the same manner as in a previous and larger work by the author, from which he has quoted some portions given here, viz., "A Handbook of Dental Anatomy and Surgery," the last edition of which was published in 1871, but is now apparently out of print. The "Notes," however, must be considered more as a compilation of memoranda than as anything like a treatise upon the subject.

GENERAL CHARACTERS OF THE TEETH IN MAN.

In undertaking the treatment of dental diseases, it is essential that the practitioner should be familiar with the

number, arrangement, and form of the teeth in man. Anatomists consider forty-four to be the so-called typical number of teeth in the mammalia. In man the number of the adult complement of teeth is thirty-two. It is therefore held that in man, as is the case in some other animals, certain teeth are suppressed; forty-four ought, as it were, to be present, but in man twelve of these are suppressed, reducing the number to thirty-two. This diminution of the typical number of teeth in man affords one explanation of the occurrence of what is sometimes believed to be a third dentition—as well as the existence of supernumerary teeth in the mouth—such unusual numbers, in both cases, indicating a return to the original or typical number which had been departed from.

These thirty-two teeth are arranged in the same way in both the upper and lower jaw—sixteen in each. In front, above and below, are four cutting teeth, flat at their edges, and termed incisors. Bounding these, on each side, is the canine or eye-tooth. Behind the canine are two teeth, termed bicuspids, or small grinders—two on each side, above and below. Behind these again are three large grinders, or the true molar teeth—three on each side, above and below. These three true molar teeth appear only with the permanent set. The first or milk set differs from the second or permanent set in being twelve teeth fewer—six above and six below; the milk set being only twenty in number instead of thirty-two, and the difference consisting in the absence of any direct predecessors to the true molar teeth.

In man the teeth are all of one length, all on the same level at the crowns, and no interspaces exist among them, every tooth being close to the one next it. The existence of unoccupied spaces among the teeth of the lower animals may explain why they suffer so much less during dentition or teething than man, where the jaw is barely, if it is actually, sufficient to contain the teeth with which it is furnished.

Each tooth is composed of three different substances, viz.—1st, a body or base, composed of dentine; 2d, a cap, investing the crown, and termed enamel; 3d, a substance coating that, and termed cement.

The character of root or fang in each tooth is one of the chief marks by which they are distinguished from each other. The natural form of root in all the incisor teeth, above and

below, is a single, straight, conical fang. In the canine teeth the same form is observed. In the bicuspids of the lower jaw the single root continues, but in those of the upper jaw it inclines to divide into two fangs. In all the upper molars the number of fangs is three; two outside, and one next the palate. In all the lower molars the number of the fangs is two, one behind the other.

A knowledge of the number, form, and direction of these fangs is essential for performance of tooth extraction, as a tooth is extracted with much more rapidity and greater ease by attention to its form and mode of fixation.

The first appearance of the teeth takes place about the seventh or eighth month of infancy, with the eruption of the temporary or milk set. As soon as the crown of the still unseen tooth is completed, and long before the root is perfect, it is "cut," as it is called. This takes place, not by the tooth forcing a way for itself through the gum and other tissues, but by these tissues themselves making a way for its escape. An opening is, if we may so speak, spontaneouly formed for it; the tooth protrudes through this opening, and to a certain extent the tooth is hoisted a little way out of the gum. This lifting up of the young tooth, on its first penetrating the gum, causes it to appear to grow more rapidly than it really does, —such apparent rapidity of growth during the first few days of a tooth's existence in the mouth being, however, deceptive.

This, in general terms, constitutes that strictly natural and healthy process going on in infant life, and termed "teething," not a step in which is to be regarded as disease. Dentition may, like every other natural process, assume a diseased or morbid condition, but in no ordinary case does it deserve the bad character generally assigned it.

The first or temporary set is soon lost and replaced by others which are to be renewed no more—the permanent or adult teeth. The various steps by which this second dentition is effected closely resemble those of the first, and it might be tedious to enter upon the physiology of the process in either case. The main difference is that the majority of the teeth in the second or permanent set have had predecessors among those of the first set; they form, as it were, a second crop, and this second crop is much longer in coming to perfection than the first was; inasmuch as within three years after birth all

the first crop had appeared above ground, whereas the second is not all up for close upon twenty years more, during nearly all which time one or other of its members has been in process of growth.

The time at which the various teeth of the first and second dentition are "cut" varies considerably. The earliest teeth to appear above the gum in the first or temporary set are the lower central incisors. This takes place about the seventh or eighth month of infant life In a week or two those of the upper jaw succeed them The lateral incisors of the upper jaw next appear about the eighth or ninth month, and those of the lower jaw quickly follow. The anterior lower molars are cut from the twelfth to the sixteenth month, and immediately after them come the corresponding teeth in the upper jaw. During the seventeenth or eighteenth month the canines appear, generally those in the upper jaw first, and before the age of two and a half years the second milk molars generally commence to make their appearance, thus completing the temporary set of teeth.

The second set generally begins to appear about the age of seven years, by the first permanent molars being then cut. These are followed by the permanent central incisors before eight, the lateral incisors about nine, the first bicuspids at ten, the second at eleven, the canines at twelve, the second molars at thirteen, and the third molars at twenty or twenty-one years of age, or about these dates as a general rule.

The structure of the three substances mentioned as entering into the formation of a tooth is peculiar, and all of them are different from each other.

Dentine, or the body of the tooth, is composed of excessively minute tubes, the walls of which consist of something like bone. These tubes are arranged so as to lie with one end opening at the centre of the tooth, the other terminating at its external surface. The use of them seems to be in maintaining the vitality of the tooth, by drawing nourishment from the vessels running along its central cavity and perhaps they serve to endow the dentine with a certain amount of sensitiveness.

Enamel consists of a collection of minute, dense, and excessively hard columns, closely packed together, and standing upon the surface of the dentine, where that substance is ex-

posed within the mouth, and for which they constitute merely a mechanically protective covering.

Cement is a substance closely resembling ordinary bone, and acts in the double capacity of assisting the central cavity of the tooth in affording nourishment to the dentine, and as a bond of union between the root of the tooth and its socket. The cement is more largely furnished with the means of deriving a supply of nourishment from the adjoining blood-vessels than the dentine; and, as the centre of the tooth and the surface of its fang are thus provided with the means of sustenance, its vital powers are sufficiently, although feebly, maintained.

Wherever any of these three substances are defective, they are, owing to the small amount of life at best possessed by them, more prone to disease and destruction. In their healthy condition nature has provided against the trying circumstances these organs are necessarily exposed to in such a locality as the mouth; but where any imperfection or disordered condition exists in the component hard structures of a tooth, the combined effect of this, and all the agencies to which it becomes exposed readily result in disease or death and subsequent decomposition or decay of its substance, constituting what is termed "dental caries." The substance of the tooth is destroyed, broken down, and removed; the central canal, largely supplied with nerves as well as blood-vessels, and the cement substance, also largely endowed with sensation, either or both become encroached upon; acute pain is the result, and toothache in its true form is produced.

CHAPTER II.

GENERAL ANATOMY OF THE MAXILLARY APPARATUS.

THE anatomy of the dental system cannot be well described or thoroughly understood without taking into account the anatomy of all those structures which, besides the teeth, are involved in the performance of mastication. These structures include the bones entering into the formation of the upper and lower jaw, the muscles moving the lower jaw, the nerves and blood-vessels supplying these parts, and the integument covering them inside the mouth—a mere résumé or memorandum of which may be here appended.

Upper and Lower Maxillary Bones and Teeth.—What is termed the arch of the upper jaw is formed by the junction of two separate bones, one for each side, and termed the right and left superior maxillæ or maxillary bones. Each of these bones contains eight teeth in the adult subject, namely, one central incisor, one lateral incisor, one canine, two bicuspids, and three molars. These two bones articulate with each other in the middle line of the face, and from their large extent assist in the formation of the orbit, the nose, the cheeks, and the palate. The superior maxillary bone is very irregular in shape. It may be generally described as possessing an external surface—that upon which the cheek rests; an internal surface—that applied to the corresponding surface of the bone of the opposite side and other parts; and a posterior surface, forming the tuberosity which rounds off the bone behind. Above it presents a smooth flat surface, which forms part of the floor of the orbit. Below it presents an arched surface, entering into the formation of the palate, and having the upper teeth projecting downward from its external border. Partly inclosed by all these surfaces, a large hollow space exists in the body of the bone termed the maxillary antrum or antrum of Highmore. This cavity is of a triangular form, and its closure is completed by certain other bones entering into the forma-

tion of the skull. The superior maxillary bone gives passage to a branch of the fifth pair of nerves through a small round opening immediately under the orbit, and enters into the formation of the nose in conjunction with the same bone on the opposite side.

The lower jaw is formed by an arched or horse-shoe-shaped bone, termed the inferior maxilla or inferior maxillary bone. It is divided into a horizontal portion, containing the lower teeth, and an upright or ascending portion, terminating in the joint or temporo-maxillary articulation at each side. These portions are named respectively the horizontal and the ascending ramus of each side, the chin being considered as placed between them in front. The ascending ramus on each side is bounded superiorly by two structures, viz., in front by a sharp and thin process of bone termed the coronoid process, and behind by another process of a thick and somewhat tuberose aspect, termed the condyle, and constituting the articular portion of this bone. Between the coronoid process in front and the condyle behind, the flat substance of the ascending ramus is hollowed into a deep notch called the sigmoid notch. Proceeding downward, we find the internal aspect of the ascending ramus perforated by a canal opening downward into the substance of the bone. This is the inferior dental foramen for the transmission of a nerve and blood-vessels into the body of the bone for the supply of the contained teeth, etc. At its lower and back part, the angle formed by the commencement of the horizontal ramus is termed the angle of the jaw, and passing forward from this on each side to the chin is what has been already described as the horizontal ramus. Midway between the angle and the chin on each side is a small round opening—the mental foramen,—and marking the centre of the chin is a somewhat elevated ridge denominated the symphysis of the lower jaw.

Such, in general terms, and without entering upon any detailed description, are the more characteristic features of the upper and lower maxillæ.

The alveolar cavities or sockets in which the teeth are implanted in these bones, consist of a series of pits arranged along the free border of each jaw, and into which the fangs of the teeth are accurately fitted. This accuracy of fitting, along with the curved form assumed by the fangs, and the union

established by the membranous structures situated between them and the sockets, explain the remarkably firm manner in which the teeth are found fixed in the jaws.

Each alveolar cavity, whether for the single root of such teeth as those having only one fang, or for any one of the fangs of teeth having several, is inclosed by four walls, one situated toward the lips or cheeks, and one toward the tongue or palate, as the case may be, in the upper or lower jaw; and besides these, two transverse walls or partitions exist, separating each alveolar cavity from the others. All these walls are perforated by innumerable minute openings for the transmission of vessels, etc., to the outside of the fang, and at the deepest part of the sockets several larger openings exist for the entrance of the nerves and blood-vessels to the pulp cavities of the teeth. The transverse walls or partitions are much less dense in their structure than either the external or internal walls; and the external wall is in nearly all the teeth much thinner and weaker than in the internal one.

These peculiarities in the alveolar cavities are important to be kept in mind with reference to extraction of the contained teeth. The exact adaptation of the alveolar walls to the form of the fang lodged within them, especially when considered along with the curvature so generally assumed by these fangs, will at once indicate the impossibility of removing the teeth from their sockets by a straight pull. On the other hand, the thinness of the external alveolar wall, with the notable exception of the posterior molars of the lower jaw, coupled with the fact that, like the stones forming an arch, the fangs of all teeth are broadest on their outer aspect, indicates that a force ultimately applied so as to dislodge the teeth in an outward direction, will tend very materially to facilitate their removal. In the same manner, the soft and spongy texture of the tranverse partitions of the alveolar ridge renders it apparent how, in using the elevator or tooth-punch, a root or stump will be easily extruded, on these walls or partitions yielding before the power of such an instrument when properly directed. The disadvantages, again, attending an unacquaintance with such matters are too obvious to require any comment here.

The anatomical configuration of the teeth themselves, implanted in the upper and lower maxillæ, differs very much

among the individual members of the series, and according as they are temporary or permanent. The four incisors of the upper jaw are single-fanged teeth, and they differ from the corresponding teeth of the lower jaw, inasmuch as, while the upper ones have round fusiform fangs, the lower ones have the fang very much flattened from side to side. The eye-teeth, or canines, possess longer and stronger fangs than any of the other teeth. The form of these fangs is a somewhat flattened cone, frequently marked on the sides by a deep groove or furrow—a construction rendering their fixation in the jaw very secure. The bicuspids in the upper jaw—two in number on each side—have their fangs either single and very much flattened from side to side, or this flattening so pronounced in the middle as to divide the otherwise single fang longitudinally; thus leading to the tooth having two fangs—one externally and one internally—both in such cases being generally round and attenuated. In the lower jaw the corresponding teeth have simple round tapering fangs, sometimes of considerable length. The molar teeth of the upper differ in an important respect from those of the lower jaw. The upper molars have three fangs, the lower have only two. The three fangs of the upper molars are arranged so that two shall be situated next the cheek—one fang behind the other—and the third fang placed inside the others and directed toward the palate. In this manner the upper molars possess one palatal and two buccal or cheek fangs, the palatal being the largest, and next to that the anterior buccal fang. The lower molars possess two fangs, one placed behind the other, and of these the anterior is markedly the largest. The fangs of the lower are generally much broader and longer than those of the upper molar teeth.

A difference has been stated as existing between the form of the temporary contrasted with that of the permanent teeth. This is not confined merely to the size of the permanent teeth being so much greater than that of the deciduous set; but the temporary teeth are peculiar in two respects—first, they have the crown very much contracted at its junction with the fang or fangs, so as to cause a bulging or shoulder at that part where the tooth rests upon the gum; and second, in all the multiple-fanged teeth in the temporary set, the fangs are spread much more widely, and their separation increases much

more rapidly toward their extremities than is the case with similar teeth in the permanent series. Both these peculiarities will be found of some service to be kept in mind in grasping a temporary tooth, and in proceeding to its extraction.

Mucous Membrane of the Mouth, etc.—The entire cavity of the mouth is, in common with other portions of the alimentary canal, lined by a structure analogous to the skin covering the external surface of the body, and termed mucous membrane. Several bodies, termed salivary glands, are associated with the mucous membrane of the mouth, and aid in supplying moisture, in the form of saliva, to that cavity. The principal glands are three in number on each side, namely, the parotid gland, the largest of the three, situated in the neighborhood of the ascending ramus of the jaw, and opening by a duct, called the duct of Stenon, on the internal surface of the cheek, opposite the second upper molar tooth; the submaxillary gland, situated under the horizontal ramus at its back part, and opening into the mouth by a duct, termed Wharton's duct, terminating under and near the front part of the tongue; and the sublingual gland, situated under the tongue on each side, and opening by several small outlets near the orifice of Wharton's duct. The whole mucous membrane of the mouth, together with the salivary glands, sympathizes largely with the teeth in their diseased conditions, and becomes the seat of many painful affections in irritation of the parts arising from this cause.

In many cases a large deposit of calcareous matter takes place from the saliva and attaches itself in thick masses to the crowns or any exposed portions of the teeth. This deposit is termed tartar or salivary calculus. The operation termed scaling consists in the removal of this substance from that surface—generally the buccal or lingual surface—of the teeth. Instruments for this purpose, termed scalers, are to be had in a variety of forms. They are used by inserting the point into or under the masses of tartar and scraping, or if in large quantity lifting, it away, taking care not to loosen the teeth in so doing. The roughness left after scaling may be removed by rubbing the exposed enamel with powdered chalk on a piece of cane or pointed wood, but the feeling soon passes off without any particular measures being employed.

CHAPTER III.

DENTITION: ITS DISORDERS AND THEIR TREATMENT.

DENTITION, in the common acceptation of the word, appears to be too frequently confined to that period at which the temporary teeth make their appearance above the gum; and in this restricted sense constant reference is made to a number of affections occurring during infancy, and attributed to the morbid influence of, exclusively, the eruptive stage of this process, under the various names of teething, cutting the teeth, etc., all having regard to the penetration of the tissue inclosing the tooth, as if this were effected, not according to a vital process, but by mechanical force, while the other stages are never taken into account at all. It is of importance, however, in the consideration of this subject, to bear in mind that the process of dentition is in all its stages a natural one, regulated by the same physiological laws as other healthy actions, and ought to proceed without constitutional disturbance. It usually does so in all animals, so far as we know, with the exception of man; and, in his case, when disturbance happens to take place, it is to be regarded as arising from some peculiar abnormal condition of the parts concerned in, and not at all as an inherent effect of the process itself.

Whatever complications may arise as secondary consequences of dentition, pain seems to be its most frequent as well as its most simple accompaniment, and it is to the immediate causes of this condition, as mainly productive in its results of those maladies observed to be more common about this age, that attention has been so often directed. In children at this age, the manifestations of pain are unmistakable, although it becomes a very difficult matter in many cases to assign to such pain an exact locality. Pain, when associated with the tooth germs, may be either of a neuralgic or inflammatory nature. Where it seems transitory or intermittent, it is probably neuralgic; where it is persistent, and especially

if accompanied by swelling, heat, or redness of any part of the gums, inflammatory action is, of course, evident. It is in either case, however, comparatively unimportant, so long as the evil is confined to the mouth. When it reacts upon the general system, and leads to functional derangement, interference of some kind becomes necessary..

If no indications of inflammation exist in the mouth, and no tooth may, according to the natural course of events, be expected to appear for a considerable time, some substance should be given the child to rub against its gums, care being taken that such substance should not be liable to breaking or passing into the mouth—such as crusts of bread, small keys, coins, and the like. In this way an increased flow of saliva is produced, and a derivative action, as well as a kind of fomentation, to the parts is obtained; and the alveoli and gums seem to be acted on, probably by the friction and pressure accelerating their absorption.

Where, on the other hand, the gum is red or hot, or appears tense and stretched by the pressure of the crown of the tooth beneath, more active measures may be employed. The chief of these is what is termed scarification. This consists in making an incision down upon the tooth, the object being to relieve congestion and to facilitate the egress of the tooth, by dividing any bands or bridles of tough mucous membrane opposing its escape. The method of performing this little operation in the easiest manner will be found to be either by the ordinary gum lancet or by means of a sharp-pointed, curved, and somewhat short bistoury—that known as Syme's abscess knife being the most suitable,—and making a crucial incision completely through the tissues covering the tooth. This should be adopted only as a last resource, and after mature consideration. Where apparently causeless convulsions, for example, occur during the active stage of dentition, or where the eruption of previous teeth has been uniformly attended with much suffering, less hesitation may be necessary; but in other cases some local evidence of irritation should always be present before having recourse to such practice. And some attention must be paid to those periods in the process of dentition when the various teeth may be naturally expected to make their appearance, because it is at such periods that this operation is most likely to be attended with benefit.

The temporary teeth are not subject to irregularity in their arrangement. This, on the other hand, is a very common occurrence among the members of the permanent set. The most marked forms of irregularity seem to occur in the front part of the dental series, generally among the teeth anterior to the bicuspids. Sometimes the irregularity is confined to mere crowding and displacement of the teeth in one or other jaw; sometimes it leads to more perceptible deformity, such as projection of the under teeth beyond the upper, leading in this way to the patient being what is termed under-hung.

The treatment of dental irregularity consists of two kinds, —first, that of providing sufficient space to accommodate the teeth in their regular order; and, second, that of forcing them into their natural situations when such space has been provided. The first step, then, being to obtain space for the displaced teeth, it generally becomes necessary for this purpose to extract one or more at some part of the mouth.' The question is, which teeth to select for removal.

A difficulty exists in most of these instances, arising from the fact that not only the present condition but the prospective circumstances of the case require to be taken into account. In many cases, for instance, in irregularity of the incisor teeth, the extraction of two temporary incisors might be required to make room for one permanent one, which may be making its appearance out of line owing to their presence. But in extracting such two temporary for one permanent tooth, we may be sacrificing the space which one of the two temporary teeth removed was, as it were, keeping for its own proper successor. In other words we should be regulating one permanent tooth at the expense of entailing irregularity on another. The extraction of the temporary canines would frequently appear to present the simplest and most obvious method of affording extra space for the incisors situated between. But as these canine teeth are not shed, nor their successors erupted, till long after the incisors on the one side of them and the bicuspids on the other have appeared in the mouth, the chances are, that by the early and premature removal of the temporary canine the permanent tooth would, at its proper period of eruption, find no space left for its occupation. Such considerations as these ought always to be kept in mind before precipitately extracting what may appear to be the tooth or teeth at fault.

The canine teeth are subject to great irregularity in position; but of all other teeth they resume their place with the least amount of interference. If, however, the anterior bicuspid threatens to leave too little space for the canine, the second temporary molar of that side should be extracted, rather than the temporary canine, as this tooth serves to keep a space vacant for its expected permanent successor.

Where all the temporary teeth are already removed, the first or anterior permanent molar is the next to be sacrificed, as this, of all the permanent set, is the one most subject to be lost.

Lastly, in such cases as those where it seems hopeless to expect that sufficient space will be gained by the removal of teeth at a distance from those to be regulated, such of these irregular teeth themselves as seem least serviceable, and most likely to facilitate the rearrangement of the others, may require removal; always bearing in mind that the canines are perhaps the most durable, and in that respect consequently the most valuable, teeth in the whole series, and the first molars the least so.

When sufficient space has been gained, the displaced teeth may be forced into position in a variety of ways. The principle upon which all of these, however, are founded, consists in a plate of metal, or other material, being accurately fitted to the palate or jaw, and so securely fastened in its place as to afford a fixed point from which the displaced teeth may be acted upon, either by being pressed into their place by little wedges, and such like means, or being dragged into it by the use of ligatures; considerable time—some months generally—being required for the accomplishment of such an object, in whatever mode it may be attempted.

As the making of such plates requires all the experience of a regular mechanical dentist, it seems unnecessary here to dilate upon their construction. What chiefly devolves upon the surgical practitioner is, to see that such plates, when supplied, are continuously worn, and to impress upon the mind of the patient and attendants the length of time required for effecting those ends for which their use is intended.

CHAPTER IV.

DENTAL CARIES, NECROSIS, AND EXOSTOSIS; ALVEOLAR ABSCESS AND FUNGUS OF THE PULP.

THE pathological conditions under which the dental tissues are met with naturally seem to arrange themselves under two separate heads. First, those where a morbid development of new tissue occurs; and second, those where the normal tissues of a tooth become deteriorated or destroyed. Exostosis of the fang may serve to exemplify the first, and, dental caries may be taken as illustrative of the second of these divisions.

The ordinary characters of caries are in general familiarly understood. It consists in a diseased condition of the dental tissues, especially of the dentine, whereby it becomes disintegrated and its lime salts disappear, leaving a large, softened, and discolored cavity in the tooth, which, when left to itself, ends in the crumbling down and total loss of the whole crown, and frequently of the greater portion of the fangs. At its earliest stages this affection usually attracts little or no attention. This arises from the small amount of sensibility existing in the dentine of a previously healthy tooth. Considerable morbid change may here, however, as in other tissues, take place without pain, and its occurrence thus be overlooked. Generally a slight discoloration exists at the site of the disease from a very early period. A dark spot or streak appears on some part of the enamel, very often at some part where it is thinnest, such as in the hollows of the crown of a molar tooth, or where the enamel becomes attenuated as it approaches the fang. At such points the flaw becomes more and more apparent; the enamel assumes a friable and undermined appearance; and at some unexpected moment, this structure gives way more or less and reveals the altered dentine below, a state of matters probably up to this time unsuspected. From this period the distinguishing characteristic of dental caries, in

character both of a constitutional affection and of a lesion produced by local causes, it seems difficult to account for its somewhat exceptional if not unique phenomena. According to one theory, dental caries is set down as an exclusively chemical process, a mere decomposition of the dental tissues. According to another, it is a purely vital action, consisting in gangrene or mortification of these tissues—neither view, however, seeming to be correct.

From what has been ascertained regarding the development of the teeth, they are originally formed from mucous membrane. We must therefore consider them as dermal organs; organs analogous to such appendages as nails or hairs, and consequently we may naturally expect them to be subject to attacks of disease such as are associated with other dermal tissues. In this manner there is no reason for considering that dental decay is an exclusively chemical action or a mere decomposition of the substance of the tooth by the action of the oral fluids. Were this the case, all teeth would be equally affected, which we know does not occur. And even if, as has been advanced, such chemical action only occurred in exposed or defective dentine, we should find broken, or cracked, or worn down, or obviously defective teeth suffering more than others; which again is far from being invariably the case. But if we admit the accession of disease as possible in any tooth, however healthy or well developed, we get rid of the difficulty, and obtain a sufficient explanation of many otherwise unaccountable facts connected with this subject. Indeed, if it be held that defective development is a necessary condition for the inroad of decay, we admit that at an earlier period of the tooth's existence the vital functions of its tissues have undergone a lesion apart from the direct action of any external causes. And if development may thus be interfered with, that is, if the nutrition of a part can be arrested or altered during its growth, there appears little difficulty in extending the proposition to its nutrition at a later period being liable to somewhat similar disturbance, leading to its vitality being diminished, and disease thus established without the intervention of any extraneous cause. The vitality of a fully developed tooth is now an undisputed fact; and being vital organs, they will at any period be subject to disease originating from within, as well as injuries occurring from without.

Many phenomena, in the accession of dental caries, bear out such a statement. The direct sequence of such an affection on various temporary conditions of the body, and of organs in no way directly associated with the teeth, is more than sufficient proof of this. The effects on them of many constitutional disorders, of mercury, of pregnancy—even of disorders of the nervous system, such as during insanity, clearly demonstrate how very much these organs are influenced by causes which must act upon them, not physically, but physiologically, and consistently explain away many or all the difficulties attaching to the older theories of dental caries.

There seems little doubt, then, that this disease may be and is originally a vital action set up in the dental tissues, whether these tissues be congenitally defective or not. Where defect does exist, dental decay may certainly be favored and accelerated by such circumstances; but it does not follow that decay is impossible in a perfectly built and well-developed tooth. On the other hand, injurious results approximating true caries may arise from local causes; but where a mere local cause is at work, as in disordered secretions within the mouth, either its effects will not be confined to one or two teeth, but will extend equally to all without distinction, or it will confine itself to mere chemical decomposition of such individual teeth as come, in some obviously exceptional manner, under its influence. Such an effect, however, would fall more correctly under the head of chemical decomposition than of disease considered as a pathological lesion, and fails to account for the vital phenomena displayed in the selective progress, the various morbid changes, remarkable intermissions, etc., in decay, already alluded to. While the first molars seem to be the teeth most liable to caries, the lower incisors are those least so. No very satisfactory explanation of the prevalence of caries in certain teeth more than in others has ever been given; but there is one circumstance here deserving of some attention. Wherever the saliva lodges to the greatest extent, there we find the largest deposit of what is known as tartar or salivary calculus; and wherever such substance is found to be most abundant, there decay will be found to be most rare. This is well exemplified in the case of the lower incisors. Here the saliva lodges continuously, and in considerable quantity; and the result is that the greatest accumulations of tartar

are always to be met with in this locality. Now, of all other teeth the lower incisors are least affected with caries, those of the upper jaw being, on the other hand, very liable to this disease. The explanation here, then, may be that the peculiar alkaline character of the saliva neutralizes any acid which might be otherwise conducive to the loss of these teeth, and in this way serves as a defence in some measure against local agencies of a destructive character to these organs.

Such, in general terms, appears to be the nature of dental caries, by far the most common disease to which the human teeth are liable, and the loss occasioned by which is so great. The question may be asked, If dental caries be a true pathological lesion, why is it that no healing process is set up by nature, so that the ravages of such disease should be at least in some cases spontaneously checked, if not repaired? That such an attempt is made by nature has been shown to be the case. The microscope has revealed certain conditions around a carious cavity, manifesting an effort on the part of nature to limit the extension of the disease. But in the majority of cases among other organs than the teeth, it must be recollected that whatever healing effort may be made by nature, it would have little chance of being successful were the diseased part subjected to the same exposure as is the surface of a carious cavity in a tooth. Here the diseased action is kept up, as would be that of an ulcer in the skin, unless properly protected; and it is so far with such a view, and on such a principle, that in cases of dental decay the operation of stopping or filling the tooth is adopted.

Besides caries, one or two other affections of the teeth render their removal in many cases necessary. From various causes, such as blows, inflammation of the alveoli, etc., a tooth may be deprived of the little vitality it naturally possesses, and in this way it may, without much alteration, become necrosed, or, what is the same thing, it dies and becomes loose. Such necrosed teeth lodging in the socket act as foreign bodies, and often give rise to much irritation; in such cases they are always better removed at once. Sometimes a tooth is only partially affected with necrosis: a part of it is deprived of its vital supply and dies. Here the irritation set up by the presence of a partially dead tooth may not be so great; but the gum is very apt to be absorbed, the alveolus to become filled

up, and the tooth to be extruded from its socket. Necrosis in many, although not in all, cases may be detected by the uniform, dark, somewhat horny appearance, generally assumed by teeth so affected. If such teeth excite no irritation, and are in any way useful, they need not be extracted; but if any irritation is set up by them, the only remedy is their removal.

Exostosis is a diseased condition very common among teeth, and the results of which occasion much annoyance of various kinds. The disease most usually consists in a thickening of the substance coating the fangs, and already described as the "cement." This thickening may be general, when it assumes the appearance of uniform enlargement of the root of a tooth, or it may be partial, and manifest itself in the form of tubercles or projections of various kinds upon the surface of the fangs. Sometimes exostoses, or nodules, or patches of a [illegible] nature occur in the pulp cavity, and occasionally even on the crown of a tooth. The principal evil effect produced is pain, and this is by no means confined to the seat of the disease, but may occur in the neighborhood of other teeth, or in the skin or cheeks, or even in localities still more distant from the exciting cause. Its detection is difficult, as no reliable indications of its presence are known. As it is generally, however, in diseased teeth that exostosis commences, some suspicion ought always to attach to such teeth where unaccountable pain occurs in their vicinity, whether they themselves may suffer from tenderness or not. Here, again, extraction is the only remedy, and will be in all probability easier to perform early in the disease, because the deposit of new matter, being originated by some irritation in the tooth, continues to increase so long as any irritation lasts; and if occurring upon the fang, such deposit may mechanically fix the tooth more immovably in its socket, by each nodule making for itself a depression in the interior of the alveolar walls.

Such are the diseases by which the greatest loss of teeth is occasioned. In necrosis and exostosis, extraction may be said to be the only certain remedy. In caries, the tooth may frequently be saved, provided the disease be treated early, by the cavity being filled up and protected in the manner afterwards to be described under the head of Stopping.

The sharp and spicular edges of the remains of carious stumps frequently cause annoyance by scratching the tongue

or cheeks. A file may be used to rectify such a state of matters, but it is much simpler and less disagreeable to the patient to cut down such points with a pair of dental excising forceps —a straight and a bent pair of which should always be possessed.

In certain cases, where the temporary set is long of being shed, the points of some of their fangs often protrude through the gum, and cause considerable uneasiness. An elevator ought to be inserted under such points, and the root prised out in this manner.

Teeth in which caries has advanced to some extent, or which have become necrosed, frequently constitute a source of much suffering and annoyance, owing to the irritation caused by their presence. The organic structures within and immediately surrounding such teeth are prone to take an inflammatory and septic action. Periodontitis is set up, followed by suppuration — the pus evacuating itself sometimes through the mucous membrane covering the alveolar walls or palate, and constituting what is called "gum boil"; or burrowing till it makes its exit at some distant point, such as through an opening in the cheek, or even as low down as the neck. Warm fomentations and the usual remedial measures employed in other forms of inflammation, or opening the abscess, may here act as a palliative mode of treatment; but removal of the cause by extracting the tooth at fault is the most certain cure in all such cases.

Another affection, also in most cases demanding extraction, is where the pulp appears as a red pouting mass protruding from the orifice, or projecting into the bottom of deep and large cavities in teeth where caries has been of rapid progress. Touching the mass with nitrate of silver may occasionally lead to its disappearance, but removal of the tooth is here also the more effectual cure.

CHAPTER V.

EXTRACTION, AND THE INSTRUMENTS EMPLOYED.

THE principal points to be attended to in the extraction are the proper seizure of the tooth, and its detachment from the walls of its socket in that direction where least resistance is likely to be met.

In seizing a tooth, whatever instrument be employed, the part upon which a hold is taken must be of sufficient strength to withstand the force necessary for dislodging the fangs. In order to obtain such a sufficiently strong portion of a decayed tooth, a part beyond the decay must be sought for. As the decay, however, frequently extends so deeply that it encroaches on those parts lying deeper than the neck of the tooth—as where the whole crown is entirely gone and a deep cavity still exists in the remains of the tooth left in the gum—the part to be grasped by an instrument will lie beneath the margin of the gum, or even that of the alveolus. The instrument must consequently be thrust with considerable force within these structures, until it reaches a firm and sound part of the tooth, and there be made to grasp it securely, but cautiously. In reaching this part some difficulty will occasionally be met with. Where the decay has advanced on one side—or it may be on more than one side—below the level of the alveolus, the instrument, instead of fixing itself beyond the decayed cavity, will be very apt to slip into it, and thereby break down the remains of the tooth. And again, when the alveolus is of dense and hard consistence, or where its walls are very thick, as is often the case in the neighborhood of the lower wisdom-teeth, it often becomes a matter of great difficulty to insert an instrument between the surface of the fangs and the socket inclosing them. Where the walls, again, are thin but dense, and firmly attached to the fangs, they are, on the other hand, apt to be seized along with the tooth, and to increase the difficulty of its removal.

The detachment of a tooth from the alveolar walls surrounding it should, as has been already said, be made in that direction where least resistance may be expected. A tooth cannot always be drawn perpendicularly from its socket. Except in occasional instances of single-fanged teeth, the roots converge or diverge, or are bent in such a manner that they would be broken across before they could be removed by a straight pull. Moreover, even when the fangs are single, and not at all bent or distorted in any way, the firmness of their attachment is so great that the amount of force which would be required to dislodge them by a straight pull would be more than could generally be applied by the hand, and would be unnecessarily severe for the patient, as it would be injuriously diffused over parts at a distance from the tooth to be removed. It is of course impossible to tell beforehand what direction or what irregularity the fangs of a tooth may possibly assume, so that, instead of attempting to take such minor details into consideration, it will be found more expedient to take advantage of some general characters which may be said to be universally present in the conformation of the teeth and their containing alveoli, and to conduct their extraction accordingly.

The fangs of all the teeth are, as has been previously described, a little broader at their external than at their internal side or border, consequently they may be moved outward much easier than inward. Again, the external wall of the alveoli is much thinner and weaker than it is internally, consequently the external wall yields much more readily than the internal one. And, coupling these two facts, it will be seen that a tooth would be much more easily dislodged by a force applied in an outward and downward, or in an outward and upward, direction in the upper or lower jaw respectively, than by any other mode. There is, however, an exception to this rule, and that is in the case of the lower wisdom-teeth, the external plate of the alveolus being in their case very much increased in thickness by the strong ridge passing down from the coronoid process of the lower jaw. As these teeth, however, are comparatively small and not generally very firm, this disadvantage is so far counterbalanced. Before dislodging any tooth in this way, however, it is in many cases well to detach it from the thin external alveolar wall by a motion inward in the first place.

Keeping these facts in remembrance, the extraction of any tooth becomes much simplified, and the form of instrument most suitable for the particular case can easily be selected. Where all or most of the crown of a tooth remains intact, extraction ought to be performed with forceps. These are instruments which, speaking in a general way, act upon the same principle as pincers or pliers would do in the withdrawal of a nail. The blades of such forceps must be adapted to the particular tooth in two ways—first, they must be so bent as to reach it easily; second, their edges must be so shaped as to be easily inserted within the alveolus. No one pair of forceps can possibly be thus adapted for all teeth, the great variety in size, form, and situation of the different teeth rendering this impossible; and although all teeth can perhaps be got out with bone-pliers, or even with a common brad-awl, yet such methods of extraction are necessarily severe and imperfect. Five pairs of forceps will be found serviceable for most purposes, and fewer will not. These are a straight pair, and a pair with the blades nearly at right angles with the handles, both of which will be required for upper and lower roots and single-fanged teeth; a pair adapted for the lower molars, and two pairs for the upper molars—one for the right and one for the left sides. Many other forms would be desirable, and may be collected, but these five pairs will be found absolutely necessary. It has been stated that the blades at their extremities should fit that part of the tooth they are intended to grasp. In this way it will be seen that for single-fanged teeth these blades will merely require to be adapted for the oval form presented by a transverse section of such fangs—hollowed out, in fact, so as to apply themselves more closely to their surface. For multiple-fanged teeth, the forceps must also be, on the same principle, adapted to the form of the surface to which they are to be applied. One pair will be found to answer for the double-fanged molars of the lower jaw, but for the three-fanged molars of the upper jaw two pairs will be necessary, as these three fangs are always so placed that two of them are next the cheek and one toward the palate; consequently the forceps which would fit one side will not at all fit the other. With this number of forceps, properly constructed, almost any case of extraction may be undertaken where forceps can be used at all.

But there are cases where forceps are unserviceable. In many instances where stumps are causing irritation, or require removal, they are so far decayed as to be altogether beyond the reach, or too friable to admit of the use, of any grasping instrument. In such cases recourse must be had to what is termed the lever, elevator, or tooth-punch. This most useful instrument exists under a variety of modifications, but in all its principle consists in an instrument terminating in a strong spoon-shaped or sometimes spear-shaped blade, from a quarter to fully half in inch long, intended to be thrust down between the stump and its containing socket, wherever a proper purchase or fulcrum can be obtained, and by which, in the manner of a lever, the remains of the tooth can be extruded from the alveolus. One or more of these instruments ought always to be at hand in every case of tooth extraction; and their mode of use is so simple, that to attempt describing the infinite variety of modifications which may be followed in their application is unnecessary. The chief point to be attended to is, that such instruments be not allowed to slip, as considerable injury might thus be done to the cheeks, tongue, or other structures within the mouth.

Another instrument, formerly much more employed in tooth extraction than it is now, is the key. This instrument, from the immense power possessed by it, is liable to abuse in its application. Its form is too well known by all who are likely to be interested in these remarks, for any description of it to be here required. Suffice it to say, that when judiciously handled, and restricted to such cases as really demanded its use, the key has been of very great service indeed, and to discard its mention altogether would be overlooking an instrument which, in certain cases, formerly acted with simplicity and effectiveness.

By attention to such matters—to the form of the tooth—to the part where it is seized—to the direction in which it is moved —and to the construction of the instrument employed—tooth extraction becomes very simple. Any hurry is inexpedient in the operation; the eye and the hand should have sufficient time to enable the operation to proceed according to what is observed or felt; and it may be laid down, that whenever the tooth is felt to be started from its attachments, be it ever so little, all the severity of the operation is over. Keeping in

view, then, these general principles, their application in the extraction of each individual tooth will vary to a certain extent, but will be easily understood if the anatomical peculiarities of the tooth to be operated on be borne in mind.

The incisors of the upper and lower jaws are seldom extracted before these teeth are either loose or reduced by caries to a condition little better than that of stumps. This latter condition is much more common in the upper than in the lower jaw; as the inferior incisors are in far the greater number of instances lost by becoming merely loosened and extruded from the socket. In extracting the upper incisors by means of forceps, the round and conical fang permits of their being rotated at the time of their being also pulled downward and slightly outward from the alveolar cavity; but in the lower incisors, the movement for their extraction must be confined to that of bending them steadily outward, or rather forward, at the same time that they are forcibly raised from their socket, as, from the laterally flattened form of the fang, any attempt at rotation here would lead to the tooth being broken. Sometimes, however, as from advanced caries in the upper, or from great crowding among the lower incisors, the forceps cannot be employed. In these circumstances, recourse must be had to the elevator. The mode of using this instrument for the removal of single fangs of any description is much the same, the principal variations in its application arising from the difficulty of access to some situations in the mouth. For removing the fangs of the upper incisors a straight-pointed elevator should be employed. It should be inserted nearly parallel with the long axis of the tooth, with its flat or hollow side next the stump to be removed, and with considerable force, and by a semi-rotatory boring motion, be made to insinuate itself deeply alongside it, between it and the adjoining root or tooth or surrounding alveolus. The instrument will then probably have obtained a hold or bite upon the stump, which should now, by making the handle of the elevator describe part of a circle, be prised outward and downward from its socket. If, after it has been started by the elevator, the fang still adhere to the adjoining tissues, it can be easily lifted away by a pair of straight and slender-pointed forceps. The lower incisors have been mentioned as sometimes requiring the elevator to be employed, on account of crowding rendering

the application of forceps impracticable. Here the same form of elevator may be used in another method. Instead of inserting it down the alveolus, so as to make it lie parallel with and alongside the fang, it may be inserted diagonally across between the tooth to be removed and the adjoining one. The hollow or flat side of the instrument must be kept next the offending stump or tooth, and, in this position, driven somewhat downward between it and the adjoining, until a hold can be obtained on the side of the fang to be extracted, when, by now rotating the handle of the instrument on its long axis, the tooth will oe forced upward and outward from its socket. In other cases the same steps may be followed as in removing upper stumps.

The canine teeth of both the upper and lower jaw offer great resistance in their extraction. This is best overcome by using a strong but narrow-bladed straight forceps, inserting their points forcibly and deeply within the margin of the alveolus until a firm and somewhat extensive grasp of the fang has been obtained; and then, with a steady and powerful movement, first slightly inward, and then outward and downward in the upper, and outward and upward in the lower, the attachments of the fang will be found to yield, when it can with but little force be lifted from the socket. The employment of the elevator is sometimes required for the removal of these teeth. But except the greater amount of force here necessary, the instrument and its mode of use is the same as has been described in reference to the removal of the incisors.

The upper bicuspids, from their fang being commonly much compressed from side to side, and occasionally divided into two slender rootlets, are more liable to fracture than the lower bicuspids. The laterally compressed fang of the upper bicuspids renders it injudicious to attempt anything like rotation in their removal; they should be grasped deeply in the socket with a slightly bent forceps, and steadily moved inward and outward until they are found to yield, and then, with a straight pull downward, not with any sudden jerk, however, their extraction may be completed. The fang of the lower bicuspids, again, is long, round, and tapering. They would, therefore, admit of rotation in their removal, but this would be prevented by the upper teeth interfering with the necessary position in which an instrument would require to be applied for this pur-

pose, except by using a forceps with long and slender beaks, bent at right angles, or nearly so, to the handles. The beaks should be deeply sunk on the labial and lingual sides of the fang, when, by rotating the tooth slightly, it will generally start upward between the blades of the forceps without further trouble. Sometimes the stumps of bicuspids, both upper and lower, require the elevator to be used for their removal; but the principles upon which this is to be done are the same as those for such single-fanged teeth as the incisors and canines, already alluded to.

The molars of the upper and lower jaws differ from each other, as has been already described, in one important point, so far as their extraction is concerned, and that this is in the upper molars possessing, besides an anterior and posterior fang, another single fang directed toward the palate. In this way the upper molars require a separate forceps for the teeth of either side, whereas one forceps answers for extracting the lower molars of both sides. The molar teeth, both above and below, especially the anterior molars, require great force for their dislodgment. In this manner a very firm grasp has to be made upon them, and should caries be advanced to any extent, fracture is thus extremely liable to occur in their extraction. This accident is to be obviated by obtaining a hold upon the tooth at as sound a part of it as can be reached. The points of the forceps blades should be thrust deeply toward the alveolus, so as to lay hold on the fangs—not the neck or crown of the tooth—and then, with a force chiefly directed outward, the tooth, whether above or below, is to be detached from its connections with the socket. The third molars or wisdom-teeth frequently present characters so exceptional, however, as to render some modification of this rule necessary. These teeth are often found directed outward or inward, or forward or backward, and in such circumstances their extraction demands a corresponding adaptation on the part of the operator. This, however, can only be, in each individual case, decided on by his own judgment and skill, the general principles of procedure remaining the same. After a molar tooth has been loosened in its socket, there is occasionally some difficulty still existing in completing its removal; and this frequently arises from one of two causes. First, in the anterior molars the fangs are often so divergent as to prevent their

passing through that part of the socket originally embracing the neck of the tooth, or even to clear the space left between those teeth immediately adjoining the one attempted to be removed. And second, in those cases where the crown of a molar tooth has been long decayed to a level with the gum, the adjoining teeth tend to bend and close over the remains of the diseased molar, and to render its extraction liable to be accompanied by loosening or even complete dislodgment of one of its neighbors, especially of the second bicuspid, where this tooth is involved in such circumstances. Where such merely physical difficulties, however, present themselves in the extraction of these teeth, there is obviously nothing except a watchful eye and a ready hand, on the part of the operator, accompanied with a familiar knowledge of the anatomical form and relations of the teeth themselves, that can be laid down as of universal application for overcoming these obstacles.

Patients frequently mistake the tooth which causes them pain. Thus where a mere stump adjoins a tooth which may have a decayed cavity in its crown, it is much more likely that the tooth is the seat of uneasiness, although the patient may think otherwise. This ought always to be kept in mind, and explained at the time, as it may save the operator from any reflection being cast upon him afterward as having taken out the wrong tooth.

Where two or more teeth are to be extracted, always commence with the one giving most pain; and, next to that, with the one most difficult to extract, and which would be most interfered with by the bleeding of any one extracted previously.

Sometimes, after the removal of a tooth, unusually protracted or excessive bleeding may occur from the alveolar vessels. In certain cases—and these are the most to be dreaded—this arises from deficient quantity or defective quality of those constituents of the blood which lead to what is termed its coagulation. Cases of this kind require medical treatment of a constitutional nature, in addition to local measures for arresting the flow of blood; but the directions for such treatment scarcely fall within the province of such a work on dental surgery as this. Where the cause is purely local, however, the treatment will be local also, and may be briefly summed up as consisting of pressure accurately applied and retained

for twelve or twenty-four hours in contact with the bleeding surface. The best mode of applying such pressure is by means of a very narrow strip of lint firmly packed into the socket of the tooth until it is completely filled—care being taken that all clots, loose stumps, etc., have been previously cleared away. Should it be desired, any of the usual styptic or astringent applications may be employed along with such pressure. The lint may be soaked in this solution previously to its being employed as a plug; but there is little doubt that whatever accessories may be had recourse to, pressure, accurately and continuously applied, is here the most reliable measure for the suppression of hemorrhage; and the absolute avoidance on the part of the patient of the common practice of sucking the wound to see whether the bleeding has stopped.

CHAPTER VI.

FILLING OR STOPPING TEETH—THE MATERIALS EMPLOYED, AND THEIR MODE OF USE.

FILLING or stopping a tooth affected by caries is an operation requiring care in many ways, and attended with considerable difficulty in its performance. Indeed, it may be stated that without some practical experience no amount of description or directions will ever enable any one to make what a dentist would call a thoroughly good stopping; nevertheless, by following out a few printed instructions, the ordinary medical practitioner might in many cases, in an emergency, or where the services of a trained specialist could not be obtained, fill or stop a tooth with such a degree of perfection as would relieve much suffering and save a tooth from destruction. The numbers of instruments and appliances constituting a full equipment for this operation, as performed by the dental practitioner, is very great, but for the ordinary medical man a very few might suffice on those occasions in which his services are likely to be called into requisition. These instruments are not always to be found in stock at the ordinary cutlers; but where this is not the case, they can always be procured by them at the various depots and manufactories of dentists' materials. Those absolutely required for the purposes under notice would as a minimum consist of a few "excavators," "bur-heads," "pluggers," and one or two small files.

The excavators are instruments for clearing out and shaping the carious cavity, and consist of slender steel rods, bent at various angles for about a quarter of an inch from the point, which is ground to a sharp chisel shape. From three to six of these might provide a sufficient number of forms to enable most cavities to be operated upon. The bur-heads, again, are similar instruments, but having a small knob or a cone-shaped enlargement at the point, which is cut like a file, and used

with a rotatory motion for opening up and dressing the cavity to be stopped. The same number of these, of different forms and sizes, might be sufficient. The pluggers are, as their name implies, used for inserting the stopping. One or two of these might be enough for the softer fillings, while those for gold or foil stoppings are sold in sets, to describe the members of which would here be of no advantage, as they require to be seen in order to being understood. The small files, in their various forms, are instruments too well known to require mention.

A tooth selected for filling should not be too far advanced in decay. The intention of the operation properly is to save what remains of a tooth. What is desirable is to fill up the cavity left by an attack of caries, and so to cover up and protect the exposed but otherwise sound dentine into which such cavity has opened. If this cavity should have extended completely through the dentine, so as to reach the sensitive pulp in the centre of the tooth, the operation becomes more complicated, and the chances of success greatly diminished. If the crown of the tooth be nearly all gone, and what remains be occasioning suffering, or where the tooth is loose, or where the root or socket is inflamed, or where gum-boil has existed in connection with the tooth, stopping, as a general rule, should not be attempted. Exceptional cases do now and then occur, but stopping, in such conditions as those described, may be undertaken by the specialist, but does not fall within the scope of the general practitioner. Here its legitimate object is that of merely plugging up a cavity penetrating the dentine, where the disease is limited to this lesion. And if patients allow the disease to proceed, or if it be overlooked in any way until total or almost total demolition of the crown of a tooth be accomplished, then extraction, and not stopping, is the proper remedy in his hands.

The first step in stopping or filling a tooth is to get ready access to the cavity, so as, if possible, to see into it. In order to do so, the patient must be placed in a position that will most accommodate the operator. Where the cavity exists between the adjoining sides of front teeth, they had better be separated by stretching a small, flat strip of india-rubber, and inserting it between them, so that, on contracting by its own elasticity, it will either at once, or in some hours afterward,

separate the teeth. If the cavity exist between the molar or bicuspid teeth, their adjacent sides should for a like purpose be cut away to a certain extent by a strong excavator or a file.

The second step is to clear out the cavity, and to shape it so that the stopping may be securely retained. A large amount of softened dentine will generally be found lining the cavity in a carious tooth; this must be cleared away by means of the small hoe-shaped instruments termed excavators, until the sound, firm, normal dentine is reached. The enamel edges forming the mouth of the cavity should be reduced to a regular form by a bur-head or excavator, so that no rough, overhanging, or projecting portions may be left. And if not perfectly cylindrical, the cavity itself, so cleared out and prepared ought to be as nearly so as possible, and, if anything, rather larger within than at the orifice.

In many cases, however, it would be disadvantageous, even if it were possible, to obtain a cavity of this kind. The decay is often shallow, although somewhat extensive superficially. In other cases, one part of it may be deep, while the rest diminishes in extent, and approaches the surface by a gradual incline—a form of cavity frequently found on the sides of the upper front teeth, where it exists as a deep excavation at the neck of the tooth, and gradually diminishes as it comes to the surface and approaches the cutting edge, until it forms a mere chink or fissure in the enamel. In these cases, the edges of the cavity should be well counter-sunk or under-cut, in order to fix the stopping in its place.

The third step is to fill the cavity. This must be done with some material which will withstand the effects of such decomposing influences as it may be subjected to in the mouth, and the usage to which it is liable in mastication. The most common substances employed are different preparations of gutta-percha, oxychlorides of zinc, etc., in various disguises and under different names, various amalgams, and gold or tin foil. Several materials are also employed as temporary stoppings, where a tooth is so tender as to render it advisable to delay filling it permanently. These are such substances as cotton-wool dipped in a solution of mastic, or of gutta-percha in chloroform, and which, by renewal from time to time, may serve to protect a carious cavity from the air until its sensitiveness becomes diminished.

Among permanent stoppings, the amalgams usually employed are those whose bases consist of various proportions of tin and silver, formed into a paste with mercury. The tin and silver, with any other metals, may be melted together and run into an ingot; this can then be reduced to filings of sufficient fineness to mix easily with the mercury when required.

Where gold foil is used as a stopping, it should be quite pure, and so thick that a leaf of it, about four inches square, should weigh from three to six or seven grains. Tin-foil may be used a little thicker.

When the cavity is prepared, as already described, it should be thoroughly dried, and kept as dry as possible during the filling process. If gutta-percha stopping is the material employed, a pellet of sufficient size is to be heated over a small flame—not in hot water—until it is as soft as it will become without burning; and if the tooth can bear it, the plug should be inserted in this state, and packed into every crevice, care being taken that especially the orifice of the cavity should be hermetically sealed up by it. The instruments necessary for this process are few and simple, and they answer equally well for amalgam fillings. They are what are termed pluggers, and consist of instruments about six inches long, having a steel shaft fixed in a handle of wood or ivory, and sometimes the shaft itself so formed as to dispense with this construction. The shaft terminates in a blunt, rounded point, bent about half an inch from the end of the instrument, so that the extremity may be easily inserted into the cavities in molar teeth, etc. Two or three sizes of these instruments will be sufficient, of the respective diameters at the point of one, two, and three-sixteenths of an inch.

Where amalgam is used, nearly the same proceedings are required as in the working of gutta-percha fillings, with the exception that the amalgam is plastic at ordinary temperatures. The metal filings and the mercury should be rubbed up together in a small mortar, and afterward kneaded in the palm of the hand by the finger and thumb, and the less mercury that can be used the better. The cavity should then be lined with the amalgam, more and more of which should be added until the stopping is complete. Neither in gutta-percha nor amalgam nor any other stoppings should any superfluous

quantity be left about the tooth, nor should any part of the stopping be allowed to press on the gum or adjoining parts.

The osteo-plastic, white enamel, rock cement, fossiline, or in other words the zinc oxychlorides and zinc pyro-phosphates, are white stoppings, which set after being introduced into the tooth, much in the same way that plaster of Paris sets in a mould. These preparations are sold in packages in the shape of a white powder in one bottle and a liquid in another; and when about to be used a little of the powder is to be mixed, on a glass or porcelain slab, with a little of the liquid, to the consistence of thin putty or dough, and inserted and pressed into the cavity to be filled, in the same way as an amalgam filling.

In these and in all other varieties of stopping it is essential that the cavity to be filled should be kept quite dry. This in such a locality as the mouth is not any easy matter, and in order to facilitate its accomplishment dentists are in the habit of using what is termed a rubber dam to protect the tooth from the saliva. This contrivance consists of a sheet of thin india-rubber or caoutchouc having small holes punched in it for the tooth or teeth to be filled being passed through. The elasticity of the rubber renders a very small hole sufficient for a tooth being passed through, and on this being done the rubber, when pressed down to the neck of the tooth, grasps it so closely as to exclude the entrance of the saliva. One or any number of adjoining teeth can be thus passed through the rubber, and the portions intervening between each hole being pressed down between the teeth and fixed there in a variety of ways, it acts as a very effectual barrier against the presence of moisture during the operation of filling. For a more detailed account, however, of this and other technical accessories in the performance of dental surgery, reference must be had to the special works published on that subject—the general principles of their employment being all that can be, or seems necessary to be, mentioned here.

Filling with gold or tin foil is a much more difficult process than either of those described. No mere description of the various modes of operating will ever enable any one to become expert at its performance without actual practice. The principles upon which this method of stopping is conducted are, that the first portions of foil introduced being actually fixed and adjusted by pressure to the floor and walls of the cavity,

and each successive portion, as it is added, being consolidated against the preceding ones, an all but solid mass of metal shall exist within the cavity on the operation being finished.

The instruments employed are in their general form adapted somewhat like those for amalgam stopping, but instead of rounded or blunt-pointed extremities, the pluggers used for foil-stopping are usually chisel or wedge shaped; and sometimes serrated at the edge. Various sizes and curves of such instruments are required to enable them most easily to enter any cavity according to its situation. The foil to be introduced may be had lighly rolled into little soft pellets, or into short cylinders, or a strip may be folded and twisted into the form of a loose rope, or, in short, fashioned in whatever form may be found to pack with most security and solidity, according to the nature of the cavity and circumstances of the case.

Whatever method be adopted, the cavity must in one way or other be packed quite full, the object in all cases of stopping being to produce a plug that shall completely fill the cavity, resist chemical action, withstand the tear and wear of mastication, and be impervious to fluids.

Where teeth are so sensitive that stopping cannot be performed, it sometimes becomes necessary to destroy the pulp entirely. In these cases some escharotic, such as chloride of zinc, or even common white arsenic is very minute quantity, may be introduced into the cavity, and retained there by a temporary filling of wax or gutta-percha for some hours, when it should be removed with the remains of any dead pulp, after which the stopping may be proceeded with.

Sometimes, after stopping with any metallic substance, heat or cold produces uneasiness, owing to the better conducting powers of such metal. Here some other stopping may be tried, as, for example, gutta-percha. But should such symptoms continue, extraction will most probably be required in the end. Occasionally, also, a stopped tooth may become the cause of insufferable pain, owing to some discharge of matter form its carious surface being pent up by the stopping. In such a case, the stopping may be removed or a hole drilled into the pulp beyond the cavity which has been stopped; but as this is almost reducing the tooth to its former condition, for which the stopping was performed, extraction is the more satisfactory treatment, where the special services of a dentist cannot be secured.

CHAPTER VII.

ON ANÆSTHETICS IN DENTAL SURGERY.

CONSIDERABLE attention has been directed toward discovering or elucidating those methods by which pain during the performance of the little operations required in dental surgery might best be diminished or altogether avoided; many of the experiments, with such a view, have been conducted with much assiduity and not a little expense; and there is no doubt that some credit is due to those who have, even by the failure of their proposed methods, contributed to our knowledge on the matter. The means adopted have generally been of two kinds, namely, 1st, the induction of a state of general anæsthesia; and, 2d, the induction of insensibility at that part only where pain is to be inflicted.

Perhaps in no other operations have the circumstances of the case to be more taken into account in the induction of anæsthesia, whether local or general, than in those performed within the cavity of the mouth. The locality itself, the severity of the pain inflicted, and, at the same time, its short duration in dental operations and the complications attendant on the interference, here sometimes unavoidable, with the function of respiration or even deglutition are circumstances which present themselves for consideration, as specially attaching to this department of surgery, and sometimes entailing extra risks to those inherent to the employment of anæsthetic agents in other cases, where the operations are in a different and more accessible quarter; and it is mainly owing to these facts that so much difficulty, and so much variety of opinion exists with reference to the employment of such obtunding agents in the practice of dental surgery.

It has always been an object with dental practitioners to discover, if possible, some mode by which local insensibility to pain during tooth extraction might be obtained, but no gener-

ally applicable or effective means of this kind have as yet been realized.

Little need be said of the attempts to induce local insensibility by mere external application of anæsthetic agents, since, as yet, it has failed to produce reliable effects anything like sufficient to enable a tooth to be extracted without pain. The subcutaneous or here rather submucous injection of cocaine—1 gr. of the hydrochlorate in 10 minims of water—has been found effective as a local anæsthetic. Its success, however, has as yet not been invariable. When applied to an unbroken surface, such as the outer coats of the eyeball, insensibility to a greater or less depth from the surface is produced; and where such superficial coverings are of so sensitive a nature as to constitute the chief seat of pain during an operation, its anæsthetic effects are unmistakable. This occurs in such cases of tooth extraction as those where the gum is the principal source of pain, as in the extraction of loose stumps, where the gum has to be somewhat roughly pushed aside in order to obtain a sufficient hold upon the stump to be removed. In the extraction of firm and less diseased teeth, however, the cocaine requires to be injected into the tissues, as has been mentioned, when in many cases it acts in this way as a mode of producing all but complete local anæsthesia. In other cases, however, even this mode of procedure has not the desired effect. Certainly not more than 1 gr. should be injected, as unpleasant after-symptoms are sometimes produced by this agent.

Congelation of the parts by the application of freezing mixtures has been suggested for the induction of local insensibility during tooth-extraction and other operations in dental surgery. This, however, is by no means easily managed, nor at all certain in its effects, while the pain produced by the freezing process itself is in many cases worse than that of extraction. Electricity, which was also at one time held in considerable repute for this purpose, need now be no more than mentioned here.

There seems, however, to be no reason for altogether despairing of ever being able to discover some mode of producing insensibility over a limited region. We know that several anodyne remedies produce this effect to a certain extent, and from the relations of the teeth to the tissues covering them—

no part of them being in reality at any depth from the surface —we may, at least, hope with some confidence in their extraction being yet practicable with much amelioration, if not entire absence of pain. In the mean time, however, no method which has been tried can ever be compared, either for facility or effectiveness, with that of inducing a state of general anæsthesia; and to do this, chloroform, sulphuric ether, and nitrous oxide gas are, so far as our knowledge of such agents as yet extends, best known and decidedly the most desirable in every way.

According to some elaborate investigations long ago made on this subject, five different degrees of narcotism seem to be producible by chloroform. The first of these includes all the effects of that agent so long as perfect consciousness remains; the second is while the mental functions are impaired, but not necessarily suspended; the third is when voluntary motion ceases—this also being the stage in which rigidity of the muscles and inarticulate mutterings occur, and the perception or consciousness of pain is lost; the fourth degree is during the complete relaxation of the muscles, when the breathing is stertorous, and the patient perfectly insensible; the fifth degree is that where embarrassment or cessation of the breathing takes place; the ultimate and greatest effect chloroform can produce being described as that where the irritability of the muscles is destroyed. These, though somewhat old, seem certainly very clear and distinct divisions of the consecutive phenomena of anæsthesia produced by chloroform. So much, however, in actual practice does each blend with and lose itself in another, that it is very rarely such stages can be made out with so much precision that they should be of much use or serve as anything like beacons by which to steer clear of danger; and as for any certain indications of having attained the sole object we desire in administering anæsthetics at all—insensibility to pain—we can confidently depend on having done so only when patients exhibit, among other symptoms, those here constituting the fourth degree of narcotism.

It would be out of place here to enter upon the views entertained and promulgated regarding death from chloroform, or any other of these anæsthetics. It is a great deal to know that death can be produced by them, and that there is no doubt of death having been so in a number of instances. It

cannot be said that in every case the system has been poisoned by them, but the patients have died; and whether their death was directly or indirectly due to them matters little, if it was due at all. The practical lesson taught is to keep a sharp look-out in every direction, to be alive to every kind of danger, and to be prepared to act at once in every emergency, as here, above all other occasions, delay or indecision is fatal.

The first and the principal object in exhibiting anæsthetics, then, is the avoidance of pain; but there are two subordinate objects which are nevertheless of much importance, and most desirable; these are the avoidance of shock to the system, and the means of rendering the patient completely passive in the hands of the surgeon. None of these ends, however, will be accomplished if the state of anæsthesia be not complete; and to produce this complete anæsthesia, and to know when it is produced, requires not only an intimate knowledge of the properties of the anæsthetic agent itself, but a certain amount of tact in its exhibition, to be acquired in no other way than by practical experience in its use.

Always bearing in mind that the part to be operated on should be placed so that the surgeon shall have the greatest possible facility for examination and manipulation, the most convenient and safest attitude for the patient during the administration of ether or chloroform is the recumbent or horizontal position. The dress about the throat and chest should be loose; the neck should in all cases be without any covering whatever; and the clothes upon the chest should be so arranged that all the movements of respiration may be at once and easily observed. In operations within the mouth it was, and to a less extent it still continues, customary to introduce a cork or some such substance between the teeth previous to or during the exhibition of the anæsthetic. In the case of ether or chloroform, although necessary in the case of nitrous oxide, such a practice is far worse than useless. The very first inhalations of chloroform in many patients create a slight degree of irritation in the fauces, often increase the flow of saliva, and generally excite a desire to swallow. This cannot be accomplished so long as anything keeps the jaws apart; the patient consequently struggles to rid himself of the difficulty; his struggles are mistaken for mere cerebral excitement; a contest takes place between the half-insensible patient and his

attendants; and probably the attempt to produce a state of anæsthesia is in the end abandoned. All such proceedings occasion delay. In exhibiting anæsthetics for such operations as those of dental surgery, it will be well to have everything so arranged that the patient may be kept under their influence for as short a time as may be compatible with the requirements of the case. The sooner the anæsthesia is here produced compatible with safety, and the sooner the patient can be relieved from its effects, when they are no longer desirable, so much the better. The operation itself ought to be completed with all possible celerity, and nothing like hesitation as to the particular instruments to employ, or loss of time selecting those required, or in any mere examination of the parts, should at this stage interfere with the proceedings. All these matters should be anticipated. The instruments likely to be used should be laid out in order before commencing to exhibit the anæsthetic; and, if possible, kept out of the patient's sight. The tooth or teeth to be extracted should at the same time be thoroughly examined, and the expedience of adopting one or other mode of extraction be then decided on. In order that speedy insensibility may ensue, perfect silence should be observed. The patient ought, if possible, to be without any apprehension that the anæsthetic is hazardous, or that no effect can be produced by it, or that the operation will be commenced before a sufficient quantity has been inhaled. Wherever a patient is nervous or anxious about these or other similar matters, it will be found that a longer time will be required than would otherwise be the case. Another point of some importance is the frame of mind in which a patient comes under the influence of this anæsthetic. If an effort be made to go over quietly, there is little chance of much struggling or involuntary restlessness. On the other hand, where a patient, especially in the case of all minor operations, entertains the belief that, under the influence of anæsthetics, the conduct is necessarily outrageous, it seldom fails that such an idea is practically realized. Indeed, in not a few instances it would almost appear as if the patient had premeditated the display sometimes made during the exhibition of such agents; and in all cases it is advisable that the patient should be instructed to remain as quiet as possible, so long as sensibility is retained. In this way, with a little effort on the patient's part, the whole

operation may be rendered much more satisfactory both to himself and the surgeon.

The mode of exhibiting the anæsthetic agent has been a subject of considerable discussion, and this is a point of some importance in dental surgery. For the exhibition of ether or choloroform various forms of inhalers have from time to time been brought forward, as preferable to exhibiting the anæsthetics in a napkin or handkerchief. It must be kept in mind, however, that the less we have to attend to besides the patient, the less risk there is of danger; whereas, if attention has to be bestowed on the working of an apparatus, complicated as these inhalers occasionally are, it necessarily interferes with that close watching of the patient which is in all cases absolutely essential. Another circumstance rendering any extra complication in the inhaler objectionable, is the frequency with which the inhalation sometimes requires to be suspended and renewed. This especially applies to protracted operations on the mouth and in its neighborhood, as, for instance, in the extraction of a number of teeth at a time, where the patient becomes conscious during the operation, and requires an additional dose of the anæsthetic to be administered, while perhaps the position of the head and the condition of the mouth would render certain forms of special apparatus difficulty to adjust, not to speak of the flow of blood rendering them dangerous.

The safest and the easiest position for the patient in the case of ether or chloroform is, as has been already said, that of so reclining on a couch or sofa, that the operator may have free access to the parts requiring operation.

It is seldom before, and generally after, the accession of insensibility, that sickness with vomiting is produced by anæsthetics; and it is only when it commences before or at this stage that it forms anything like a serious impediment to the surgical procedure, as, after this is effected, its occurrence is of but little consequence. It is superfluous to say that of all operations those on the mouth and in its vicinity are such as are most interfered with by vomiting. In this way it becomes a complication of a most troublesome nature to the surgeon. But it by no means rests here; for it also entails most serious risk to the patient, inasmuch as in many cases there results from this cause very great danger of suffocation. The vomit-

ing, when anæsthesia is deep, often seems to be defective—the contents of the stomach gurgling up into the mouth, in small quantities at first, and, with the mouth widely opened, as it might inadvertently be kept during such operations, there is an inability either to swallow or to eject the vomited matters.

Nitrous oxide, or what is more familiarly known as "laughing-gas," is an anæsthetic now more largely employed in dental operations of a short duration than either chloroform or ether. Its exhibition is somewhat more complicated in its details, and the insensibility induced by it of a much more transient nature than these agents, and seldom lasting for more than about half a minute in its full effect. It is not, like the others, a fluid, but a gaseous compound, although under great pressure it can be reduced to the liquid state, in which, for the sake of portability, it is generally stored or carried about. The mode of its exhibition is through a face-piece, covering the nose and mouth, and connected by a tube with a bag containing the gas. The tube is provided with a stop-cock, by which the supply of gas can be turned on or shut off by the operator, while the bag is provided with a similar apparatus connecting it with the reservoir of gas, which generally contains it in the liquid state. The whole apparatus, including the iron reservoir containing the gas, is to be had, ready for use, at the various dental depots throughout the country. In employing this anæsthetic, the same conditions and precautions mentioned as important in the use of other anæsthetics are necessary to be observed. Owing to the brief continuance of the anæsthesia induced, it is here necessary, in order to lose no time in operating, to introduce a gag between the patient's jaws previous to commencing the administration of the gas. These gags are provided in pairs along with the rest of the apparatus, and are generally connected together by a piece of cord, partly to facilitate their use and partly to guard against danger should the one placed between the jaws accidentally slip into the patient's mouth. The face-piece being adjusted in position, and moulded to the cheeks and other parts of the face, and kept there by such pressure as will exclude the access of all atmospheric air, the gas is turned on. Here the exclusion of atmospheric air is indispensable, while in other anæsthetics this would be fraught with danger. After from thirty seconds' to two minutes' inhalation of the

gas, insensibility should be completed, and a longer time than this being required indicates the exercise of increased caution. Various modes of ascertaining when full insensibility is induced have been recommended. The fixed appearance of the eye on opening the eyelids; the non-response of the patient to a request to raise the hand; a peculiar change in the mode of breathing, and allied to a stertorous character of respiration, along with the general impression of unconsciousness conveyed by the patient to the operator, may all be taken as affording the cue to the time for commencing the operation, which should now be proceeded with as rapidly as possible. Very frequently, during its progress, the patient appears to recover consciousness, and indicates a feeling of pain or alarm, but, as a general rule, on complete recovery nothing of this kind is remembered. Sometimes a feeling of extreme prostration, or sickness, or headache follows the use of this anæsthetic, and in certain instances the patient feels the consequences of the gas, more or less, for the whole day after its administration. There is no doubt that in successful cases this anæsthetic is more convenient in many ways, both to the patient and the operator, than the other anæsthetics here alluded to, and in a certain sense it is safer; but it must not be supposed to be exempt from danger. Its timely withdrawal, and the speedy recovery from its effects in healthy patients, not too young or too old, reduce the dangers it might entail to a minimum as an anæsthetic, since it does not seem to leave any toxic material in the system, and which requires to be got rid of, as is the case with chloroform, ether, and the like, but simply requires the readmission of oxygen to the blood to effect recovery. But let its administration be a very little too much prolonged, or let the patient be the subject of certain unhealthy conditions of the lungs or blood-vessels, where any occurrence approaching stasis or congestion would be contra-indicated, and untoward or fatal results may, in any case, occur. The appearance of the patient under the influence of nitrous oxide, in nearly every instance, manifests the existence of considerable venous congestion, and the mode of action of the anæsthetic in replacing the oxygen ordinarily taken up by the blood from the air during respiration, without conveying any of its benefits, point to its influence being closely allied to the nature of asphyxia, with the characteristic distention of the heart and

great vessels. In this way it will be seen that the existence of atheroma, a tendency to hæmoptysis, degeneration of the ventricular walls, and such like conditions might, during the exhibition of nitrous oxide, incur extreme risk, and that, too, without necessarily manifesting itself at the moment of its administration.

From what has been said it will be seen that nitrous oxide is not an anæsthetic likely to be available to any great extent by the ordinary medical practitioner in the cases of dental surgery coming under his care. The combination of that anæsthetic, again, with others, such as ether, and the more complicated apparatus required in this case, are still less fitted for his requirements, being more adapted for the operating rooms of practitioners who have made dental surgery their special branch of practice. These latter, then, along with various agencies from time to time introduced as anæsthetics, but which have as yet not come into general use, need not be discussed in this place, as those given seem, in the mean time, sufficient for the cases of dental surgery in which the general medical practitioner is more frequently called upon to operate.

ON

SOUNDING FOR GALL-STONES;

AND THE

Extrusion of Gall-Stones by Digital Manipulation.

BY

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ON

SOUNDING FOR GALL-STONES.

THAT within the last fifty years the whole theory and practice of medicine has undergone a complete revolution, no one seeks to deny. That a new era dawned upon our art when the microscope, stethoscope, test-tube, and thermometer crossed the threshold of the sick-chamber, all readily admit. But there are still among us many who insufficiently appreciate the immense collective advantages which have accrued to rational medicine from the hundred and one trifling physical aids to diagnosis which have been introduced during the last couple of decades. This arises from the majority of persons overlooking the fact that a few easily recognizable physical signs are worth a whole cartload of describable symptoms in the detection of obscure disease. For while symptoms are, even at best, merely fluctuating quantities, not alone from their intrinsic value materially depending upon the mental capacity, moral courage, and veracity of the narrator, but from their very significance being complex. A physical sign, when correctly interpreted, has always the same definite and indisputable value, from its being an independent factor, which the interrogator sees, feels, or hears for himself. Added to this, the knowledge of the fact that the cable of symptomatology is nearly "payed-out," and consequently the onward career of rational medicine to her legitimate goal—that of an exact science—must in future almost entirely depend on the acceptance and judicious application of easily workable physical aids to the recognition of internal diseases, induces me to avail myself of this favorable opportunity of making known to my professional brethren an in-

strumental method of indubitably ascertaining the existence of impacted gall-stones—a point of no mean importance, seeing how many difficulties beset the symptomatic path of diagnosis in this most fatal form of affection. Before proceeding to do so, however, it is advisable for me to make a few prefatory remarks on the clinology of biliary concretions. For, judging from the reports of the speeches made at our metropolitan as well as our provincial medical societies, when the subject of gall-stones is discussed, a woeful amount of ignorance regarding both their symptomatology and pathology is prevalent in the profession. This may to some appear strong, if not even ungenerous, language. But every one who has given attention to the reported remarks of some of the speakers, hospital physicians as well as surgeons, in the discussions which have followed the reading of recent papers, will acknowledge that they are perfectly justifiable. I even doubt not that some of the speakers themselves, after they peruse the facts I shall presently adduce, will feel that this stricture is by no means uncalled for.

One of the commonest of the false statements enunciated is that gall-stone affections are not generally dangerous. Exactly the contrary is the case; the general ignorance of the fatality of gall-stone cases being due to the unfortunate frequency with which patients succumb to them without the medical attendant's having had the remotest idea of the true pathology of the case he was treating. The reason of this is not far to seek. It lies, I believe, in the fact of his having been falsely taught that all dangerous gall-stone cases are associated with jaundice and paroxysmal pain; whereas it actually happens that the majority of fatal gall-stone cases are unassociated with either the one or the other of them. Incredible as this may appear, it is nevertheless perfectly true. For there is no jaundice, and no paroxysmal pain (indeed, in the first instance very little pain of any kind whatever) when a gall-stone ulcerates its way out of the gall-bladder. Should the stone in this case enter the peritoneum, a fatal peritonitis is the result. Should it enter the intestines, if large it kills the patient by ileus; if small, it passes safely down the intestines until it reaches the ileo-cæcal valve, where it often sets up such an amount of irritation as speedily induces a fatal enteritis. The unsuspected gall-stone may kill even more

rapidly still. As when in the course of its perforating career it opens a blood-vessel, which, if it pours its contents into the stomach, leads to the mistaken diagnosis of hæmatemesis; if into the intestines, gives rise to bloody stools. Or it may burst into the peritoneal cavity and the patient become suddenly collapsed, and die without either a single trace of the hemorrhage or its exciting cause being visible to reveal the true nature of the case. That such fatal cases of gall-stone perforation are far from uncommon I know from personal experience. No less than four, and strangely enough all in gentlemen of above forty years of age, have fallen under my notice within the last year. One died six hours after I saw him, another within twelve, a third within forty-eight, while the fourth happily recovered, and that, too, notwithstanding that pure blood was passed both by mouth and rectum.

As it may appear to some a novelty to be told that gall-stones are so often fatal without so much as their existence having been suspected, and a single illustrative example is more impressive than a whole column of general remarks, I shall briefly relate one of the fatal cases just referred to, which has the additional advantage of showing how, even when gall-stone symptoms exist, one may be entirely misled in both diagnosis and treatment, from their not being in exact accordance to what is regarded as orthodox law. Early in the present year I was summoned to Brussels to see a Belgian gentleman, aged fifty-eight, along with Mons. Capart. On reaching the patient's bedside I found him ex-sanguine, and almost pulseless. He complained of dull pain in the lower part of the liver, with great tenderness on pressure in the region of the gall-bladder, which was not distended. The liver was of the normal size, and there was no jaundice. The history I received was, that he had always been a bilious subject, and had suffered from painful dyspepsia, that he once had jaundice, and passed a small gall-stone. The dyspeptic symptoms not improving under treatment, he betook himself to Paris, and consulted the gentleman who was recommended to him as being the leading physician. After a careful examination of his case it was diagnosed "hepatalgia," and a course of electricity was prescribed. Feeling no better after several weeks of daily galvanism he returned to Brussels. His symptoms gradually became more severe, and four days before I saw

that he was suddenly seized with coffee-ground vomiting, and tarry-looking dejections. Seeing that the case was undoubtedly one of gall-stone perforation, and that the patient was already blanched from loss of blood, I naturally enough prognosed that if the hemorrhage was not immediately arrested death was inevitable. For twelve hours he rallied under treatment, but within the next twenty-four, pure blood began to come away, both upward and downward, and in less than forty-eight hours from the time I first saw him he was a corpse.

The prevailing ignorance regarding the fatality of gall-stones may also in a measure be due to the fact that not only are the poor far less liable to them than the rich, but when they seek relief for them in hospitals, the prominent sign instead of the pathological conditions giving rise to it is often treated as the disease. As well as that from its being no rare occurrence for gall-stones of considerable size to be met with at the autopsies of patients who, during their sojourn in the hospital, never manifested a single symptom of them, even hospital physicians have been led to regard them as harmless. The entire absence of both signs and symptoms in many gall-stone cases is, however, readily explicable, without its entailing a belief in their non-dangerous nature. For it is due to the fact that, from the majority of gall-stones being slowly formed in the gall-bladder itself, they give rise to no signs or symptoms as long as they remain there. No, sometimes not even to biliary functional derangement, though the viscus be chock-full of them. This is on account of a gall-bladder not being essential to life, as is proved by the fact that people have grown up to adult life without having ever possessed a vestige of one. And many species of animals have normally no gall-bladders, for example the horse and the deer. There is nothing, then, surprising in the fact that gall-stones, though fatal things, may yet be found in necropsies in the gall-bladders of persons who never complained of them. Indeed, I would rather be surprising if it were otherwise, seeing that they are usually formed there and that their power of discomfort and mischief only begins when they attempt to get out of the gall-bladder either by directly perforating through its coats, or by forcibly entering the cystic duct.

From the remarks which fell from the speakers on the dis-

cussion on my recent paper on "Gall-Stone Sounding," at the Royal Medical and Chirurgical Society, it further appears to be very far from generally known that, notwithstanding that a dozen—even a thousand—gall-stones may exist for years in a patient's body, without giving rise to a single sign or symptom by which their presence can be suspected, all the most marked signs as well as symptoms, given in text-book as indubitable evidence of the existence of dangerous gall-stones, may be present without a single stone or biliary concretion of any kind whatever existing in the sufferer's body. This is a startling fact, no doubt, but it is nevertheless quite true, as I shall now proceed to show. For:

(*a*) Gall-stones never produce jaundice, pipe-clay stools, nor bilious urine, except when they become impacted in a duct. And the only ducts in which their impaction leads to this result are the hepatic and common bile ducts.

(*b*) Not only can their presence in these ducts in the majority of cases be recognized, but even differentiated. And what is more, their impaction in the intra-hepatic as well as in the cystic duct can also be detected, though in these cases there is no jaundice, no pipe-clay stools, and no saffron-colored urine. In order to make this perfectly plain I shall put the matter in the form of an easily comprehensible table.

The Presence of the Signs and Symptoms is Indicated by the Figures, the Absence by the Lines.

Gall-stones Impacted in:	Distended Gall-bladder.	Enlarged Liver.	Jaundiced Skin and Eyes.	Pipe-clay Stools.	Saffron or Black-colored Urine.	Rigors or Chills.	Vomiting or Nausea.	Flatulent Dyspepsia.	Hepatic Tenderness.	Spasmodic Pain.
The common bile duct....	1	2	3	4	5	6	7	8	9	10
Hepatic duct.....	—	1	2	3	4	5	6	7	8	9
Cystic duct	*	—	—	—	—	1	2	3	4	5
Intra-hepatic ducts.....	—	—	—	—	—	—	—	1	2	3

After having thus shown how comparatively easy it is not only to diagnose, but even to differentiate the various forms

* Although the gall-bladder is in these cases never distended with bile, if the impaction be complete, and is continued sufficiently long, it may become distended by white mucus-secretion. For the *modus operandi* in the formation of white liquids in the gall-bladder, see the writer's book on the liver, where its physiology as well as pathology is given in detail.

of impacted gall-stones, the reader may perhaps wonder why I take so much trouble to make known an instrumental method for detecting them. Here is my reason, and a very potent one it is. More than twenty years' experience of gall-stone cases has not only convinced me that many patients annually die from the effects of impacted biliary concretions, whose lives might in all probability be saved were the obstructing body artificially extracted; but at the same time made me painfully conscious that, as has just been shown, all their most characteristic signs and symptoms may be manifested by a patient who has not a vestige of a biliary concretion of any kind whatever within his body. I believe, therefore, that it would not only be injudicious, but criminal for any physician to recommend to a patient to submit to what a hospital-surgeon had the temerity, at the debate on my paper, to deliberately propose doing as a means of diagnosis. Namely, to incise a patient's abdomen, cut open his gall-bladder, stitch its edges to the lips of the wound in the abdominal parietes, and then search for the impacted stone in it. Showing that his idea was, that dangerously obstructing calculi are to be found in gall-bladders. Moreover, be it noted that this formidable diagnostic procedure was proposed by him as being simpler than the operation of sounding with a trocar not bigger than a knitting needle. I shall now show how this venturesome form of surgical prospecting is unjustifiable. For even should an inoffensive calculus be accidentally found in the gall-bladder and removed, it would not as a sequence follow that the patient's abdomen had been necessarily and advantageously incised. For the following potent reasons:

(*a*) It is in no case the stone itself which produces the dangerous symptoms; but solely the obstruction to the flow of bile into the intestines. In so far then as the stone is concerned, did it not prevent the passage of the bile into the duodenum, it would in all probability lie as inoffensively in the bile duct as stones are known to lie in the bile reservoir.

(*b*) It being the obstruction then, and not the stone itself which is the real source of danger to life, any other equally potent obstructing cause acts in precisely the same way as an impacted stone does. This is no mere supposition, it is a fact.

(*c*) For it is found that the identically same signs of jaundiced skin, pipe-clay stools, bilious urine, etc., are met with

when the hepatic or the common bile duct is obstructed by entozoa, cancerous or other tumors growing within them. Or when by external pressure a tumor of the head of the pancreas, of the pylorus of the stomach, or of the liver itself blocks up the channel of the duct. An additional common cause of permanent obstructive jaundice, is the closing up of the duodenal orifice of the bile duct by a cicatrized ulcer. All of which non-gall-stone forms of obstruction not unfrequently baffle even the most skilled specialists to differentiate. It is scarcely surprising then that I strongly advise practitioners to make themselves perfectly sure of the obstruction being due to a gall-stone before proceeding to lay open their patient's abdomen in the sanguine expectation of finding one.

Although my method of sounding for stones may not be entirely devoid of danger—for no operation on the human abdomen is, not even the simple one of tapping—it certainly has the advantage of being less rash, as well as less dangerous to life than that of cutting down with a knife, either on ducts or gall-bladders, in search for gall-stones which may have no existence. Moreover, I have already performed the operation successfully, and what has been done once may be done again. The instrument employed was a six-inch long French exploring trocar, of somewhat less diameter than an English No. 1 catheter. And I now recommend that it should be provided with a blunt-nosed steel pilot, to be introduced after the trocar has been inserted into the abdomen, and before the search for the stone is proceeded with.

After the patient is put under the influence of an anæsthetic, the operation of sounding may be performed in the following wise:

1st. Push the trocar through the abdominal parietes in the direction of the common bile duct.

2d. If the instrument impinges on no hard solid, withdraw the stilette and judge of the situation of the canula's point by observing what kind of fluid flows from its free orifice—bile, abdominal serum, blood or intestinal fluid.

3d. Being satisfied that the point of the cannula occupies no dangerous position, introduce the blunt-nosed pilot, and proceed to search about in all directions for the stone. The presence of one will be readily recognized by the fact that no hard substance whatever exists in the neighborhood of the

gall-bladder and bile ducts. And a gall-stone when struck, either in the gall-bladder or ducts, gives the same characteristic sensation to the fingers as a urinary calculus.

As several of the speakers at the debate on my paper objected to this plan of sounding, on the ground of the danger of peritonitis being induced by the bile escaping into the peritoneal cavity, notwithstanding that I had cited a case where no less than thirteen pints[1] were removed by tapping from the abdomen of a boy whose gall-bladder had been ruptured three weeks previously. And they ought to have known that both distended gall-bladders and bile ducts have been beneficially tapped, I deemed it advisable to see what would actually be the result of puncturing a distended gall-bladder with my exploring trocar. Especially as one of the speakers had, forgotting that the coats of bile ducts and gall-bladders are elastic, inconsiderately suggested that the moving about of the instrument would enlarge the puncture.

Accordingly, along with Prof. Schäfer, I performed the following experiment: A dog which had been kept fasting for twenty-six hours, in order that his gall-bladder might be fully distended, was rendered insensible with chloroform. The abdomen was opened, and into the distended gall-bladder I inserted my trocar, twisted it about and then withdrew it. No spurt of bile whatever took place. Nothing more than an oozing followed. The oozing even soon ceased, from the coats of the gall-bladder (which, be it remembered, are even very thin in a small dog) contracting as the viscus emptied itself. In order, then, that all risk of a dangerous exudation of bile into the peritoneal cavity may be avoided, it is merely necessary to withdraw some of it before removing the canula.

In those cases where the obstruction has given rise to great distention of either the bile duct or the gall-bladder, and from the orifice of the canula bile flows when the stilette is withdrawn, it might perhaps be advisable to empty them of their biliary contents before proceeding to search for the suspected stone. (Dr. Whittaker detected gall-stones in the gall-bladder by means of an aspirating needle ("New York Medical Record," 1882), and on one occasion, while I was exploring a liver, the trocar accidentally penetrated the gall-bladder and struck a calculus, which subsequently, at the autopsy, was found to be of the size and shape of an apricot stone.)

I shall now give the history of the case of impacted gall-stone in which I successfully performed the operation.

The patient, a delicate constitutioned lady, aged thirty-six, married, and the mother of several children, had for many months suffered from all the worst signs and symptoms of obstructed common bile duct. Not only was her abdomen greatly distended with ascitic fluid; but she was so weak and near to the point of death that both Dr. Diver—her regular medical attendant—and I, believed that the only chance of prolonging her life lay in the artificial removal of the obstruction. Before, however, calling in an operative surgeon to perform bilotomy, we deemed it prudent to make perfectly sure that the obstruction of the bile duct was due to the presence of a stone, as neither of us had any wish to see the poor sufferer's abdomen unnecessarily opened. Accordingly, a day or two after a gallon of ascitic fluid had been withdrawn from her abdomen, she was made insensible with A. C. E. anæsthetic mixture (given because of her having a weak heart). I then introduced an exploring trocar (in the manner before described) at a point midway between the lower margin of the liver and the umbilicus; but an inch and a half to the right of it. Fig. 1.

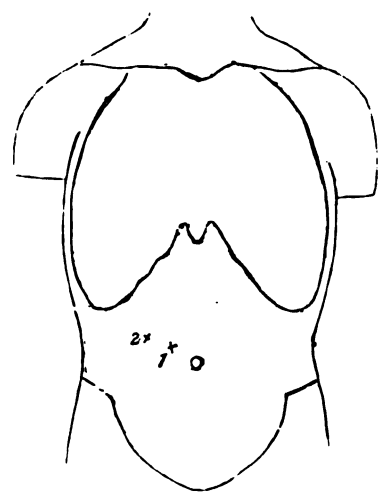

FIG. 1.

The instrument was then slowly pushed upward, outward and backward in the direction of the common bile duct; but although it was inserted up to its hilt (six inches) in the still distended ascitic abdomen no hard substance was encountered. In order to ascertain the exact position of the canula's point, I withdrew the stilette to see if any, and what kind of fluid would flow from it. As nothing but ascitic fluid came away, its point was known to be free in the abdominal cavity, so I proceeded to search with it in all directions for the suspected stone. The search proving unsuccessful, the instrument was withdrawn and reinserted an inch higher up, a little more to

the right. Fig. 2. On again pushing it in the direction of the common bile duct, just as it reached its full depth of six inches, its point not only impinged upon, but stuck in a hard substance. The sensation communicated to the fingers, as well as the faint sound emitted when this was tapped against with the blunt end of the canula, left no doubt upon my mind that it was a calculus. The next point was, if possible, to ascertain its size, by pressing the end of the canula firmly against it, and running the point of the instrument round it. The impression so derived was that the stone was of the size and shape of an ordinary hazelnut. As no blood whatever flowed from the punctures, either during or after the operation, these orifices were simply covered over with a piece of sticking plaster, and the abdomen bound up.

The sounding having thus completely confirmed the symptomatic diagnosis, and further shown that the obstructing stone was no bigger than a moderately sized hazelnut, it was deemed advisable, before subjecting the patient, in her exceedingly weak state, to the severe operation of bilotomy, to delay a few days in the hope that, under the influence of medicine, the stone might pass along the duct into the intestines. Most fortunate this determination turned out to be; for at my next visit—six days after the sounding—I found all the signs and symptoms ameliorated. The stools had not only already become of their normal color (which they had not been for many weeks), but the urine had lost its bilious hue, and the skin was less jaundiced. Besides which, the previously distended gall-bladder was now no longer perceptible to the touch. Changes which, when considered collectively, led to but one conclusion, namely, that the duct was free—that the stone had passed. As it had not, however, been found in the stools, it was thought to be still within the bowels, experience having taught me that stones after having safely reached the intestines do not always immediately come away, but often remain in them for weeks, sometimes even for months.

No untoward symptom resulted from the operation. Everything went on well until the eleventh day after the sounding, when pain and tenderness were complained of in the right iliac region. The pulse became rapid. The temperature rose, and signs of enteritis speedily followed, no doubt from the usual cause in such cases, namely, the irritation produced by

the stone getting lodged in the ileo-cæcal valve. Its ordinary concomitant, peritonitis, supervened, and notwithstanding that the patient had regained considerable strength during the eleven days of convalescence after the sounding, she sank and died twenty-seven days after the operation, which had so fortunately led to the accidental dislodgment of the stone, after its having been for so many weeks previously firmly and dangerously impacted in the duct. A theory of the cause of the sudden extrusion of the stone shall be given presently. Meanwhile I will give the result of the necropsy, which consisted of an examination of the liver, its biliary appendages, and their intestinal attachments, all of which parts were kindly forwarded to me by Dr. Diver. Their examination yielded the following interesting information:

1st. The gall-bladder, in so far as bile was concerned, was found empty, for it contained not more than half a drachm, clearly proving that the obstruction to the outflow of the bile had ceased before the patient's death.

2d. The gall-bladder contained thirteen biliary calculi. The three largest lay in a row, and fitted on to each other's ends by facets. The largest of all, which lay with its broadest end downward against the orifice of the cystic duct, was seven-eighths of an inch long, and six-eighths of an inch broad. In contact with its upper facet was an angular-cornered stone of the dimensions of a moderately sized hazelnut, against the upper end of which lay the smallest of the three. It differed from its two companions in being facetted at its lower end only. The gall-bladder was contracted upon the stones.

3d. The fact of the calculus impinging on the orifice of the cystic duct having a facet at its lower end of the same size as that at its upper, and there being no stone to correspond either in size or shape to it in the gall-bladder or bile ducts, leads to the irresistible belief that the calculus which belonged to this facet must have not only escaped from the gall-bladder, but from the common bile duct during the lifetime of the patient.

4th. The fact of all the signs of an obstructed bile duct having suddenly vanished after the sounding, favors the theory that the passage of the stone from the bile duct was in some way or other directly connected with the operation.

5th. The extrusion of the stone from the duct after having been so long and so firmly impacted in it, may be accounted for in the following manner:

Assuming that it was as angular at its corners as th hazelnut-sized one found in the gall-bladder, it is easy to im agine that it was sticking angular-wise in the duct when th sounding was performed, and that the pressure exerted on it corners, when the canula was being passed firmly round i in order to ascertain its size, altered its position in the duct and from its assuming a more longitudinal one (the othe stone was slightly oblong) it was enabled to slip along an out of the duct into the intestines.

Now comes the important question:

Of what practical good is the narration of this case?

I reply—Of great practical good, if its teachings are prop erly considered. For its history clearly establishes the follow ing points:

A. That the presence of an impacted gall-stone may, under similar circumstances as the above, be indubitably ascertained by instrumental means.

B. That not only can the exact position and probable size, but under favorable circumstances even the very shape of an impacted gall-stone be instrumentally ascertained.

C. That the operation of sounding for gall-stones in the way here advocated is as safe in skilled hands as the tapping of a distended gall-bladder or ovarian cyst.

D. A knowledge of the clinical facts adduced may possibly deter enterprising surgeons from laying open the abdomens of patients in search for gall-stones which not only possibly but even probably have no existence whatever.

E. While the fact of being able to indubitably ascertain the existence of a gall-stone without undertaking the severe operation of incising the abdomen, on the mere chance of find ing one, may induce physicians to recommend patients suffer ing from suspected dangerously impacted biliary concretions to submit to the operation of sounding, with the ulterior view, if a stone should be detected, of advising its extraction. Seeing that in a number of instances the removal of the im pacted stone from the duct by the surgeon's knife offers the only chance of saving the patient from an untimely grave.

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THE

EXTRUSION OF GALL-STONES

BY DIGITAL MANIPULATION.

HAD modern discoveries in physical science not already abundantly and conclusively demonstrated the fallacy of the hoary-headed saying that "there is nothing new under the sun," the recent improvements in medicine—notable in hepatic surgery—would of themselves have sufficed to dethrone this erroneous adage. The last dozen or so of years has been so fruitful in novelties connected with the diagnosis and treatment of liver diseases, that those who have not kept themselves *au courant* with recent hepatic literature are scarcely able to recognize any of its old land-marks. Even within the last year or two, among other novelties, have been discussed and adopted hepatic phlebotomy, puncturing of Glisson's capsule, sounding for impacted gall-stones, and duodeno-cholecystostomy (uniting gall-bladder and duodenum, so as to make an artificial passage for the bile into the intestines, in cases of permanent occlusion of the common duct).

And now I am about to add another novelty to the list; but before doing so I may further remark that, in addition to these quite recent surgical improvements, the researches of the last decade have not only taught us that gall-stones, but even all the other forms of liver concretions—to wit, inspissated bile, bilary sand, and gravel—which occasionally give rise to such painful symptoms, are by no means the mere harmless pathological curiosities we were wont to believe; as well as that the co-existence of the formerly supposed-to-be

pathognomic sign of jaundice, is no more necessary for the diagnosis of a biliary concretion in any given case, than it is to enable the expert to prognose the insidious approach of a fatal termination; and that, too, even in those exceptional cases where the signs and symptoms lead the uninitiated to regard them as being merely the direct result of a simple form of dyspepsia, a temporary colonitis, a subacute peritonitis, or, it may be, a transient bilious indigestion.

Such being the case, it is possible that the reader will not feel displeased at my giving a brief *résumé* of what I consider to be the diagnostic signs and symptoms of biliary concretions, before entering upon the consideration of the extrusion of gall-stones by digital manipulation.

1st. I may remark that all forms of biliary concretions—namely, gall-stones, gravel, inspissated bile, and mere biliary sand—give rise, as a general rule, to precisely identical kinds of signs and symptoms. 2d. That every one of them, not even biliary sand excepted, has again and again proved fatal without their existence having been diagnosed, or so much even as been suspected, during the life of the patient. 3d. That biliary concretions occur at every period of life between the cradle and the grave. 4th. That the epileptic convulsions of infancy, as well as the "windy spasms" of the babe at the breast, are oftentimes due to the local irritation caused by biliary concretions. 5th. That instead of being rare varieties of liver disease, biliary concretions, in one form or another, are the commonest of all the various kinds of hepatic affections met with among the better class of patients in this country. 6th. Biliary concretions—more especially in the shape of gall-stones—are not only much more frequently than is usually supposed an immediate cause of death, but when long impacted in the bile ducts—either in the hepatic, cystic, or common duct—a fruitful cause of hepatitis, hypertrophic indurations, cancerous and other forms of liver-tissue degenerations, as well as of permanent occlusions of the ducts and atrophic cirrhosis, attended with ascites and dropsy. It is lucky, then, that the days of our ignorance, when biliary concretions were regarded as harmless curiosities, have been buried in oblivion by the united efforts of modern experimental physiology and physiological chemistry; the two departments of scientific medicine which, within the last quarter of a cen-

tury, have done more to place liver pathology on the proud pedestal it now occupies than all the previous centuries of practical clinical work put together.

Moreover, not only in the majority of instances can we now diagnose the presence of biliary concretions in the bile ducts with comparative facility, as well as certainty, but it is oftentimes within our power to fix upon the exact spot at which the concretion is acting deleteriously, as may be seen by the subjoined table, which is a modification of the one I gave in my pamphlet entitled "Sounding for Gall-stones."

The following table shows that biliary concretions never cause jaundice except when they occupy either the hepatic or the common bile duct. And what is more, not even then (although they may be by their presence killing the patient), unless they completely obstruct the flow of bile into the intestines. It is the want of this single piece of knowledge which so frequently leads men to fritter away the lives of patients by treating cases of biliary concretions as if they were merely stomachal or intestinal derangements, until the curable stage of the mischief has slipped away, and there is nothing left to be done but to allow the tomb to claim the victim.

The Presence of the Signs and Symptoms of the Biliary Concretions is Indicated by Figures, their Absence by Lines.

Biliary Concretions impacted in:	Indigestion and flatulent distention of Stomach and Intestines.	Dull aching or acute Epigastric Pain.	Nausea or Vomiting.	Chills or Shiverings.	Tenderness on Pressure over Gall-bladder or Liver.	Jaundiced Skin and Eyes.	Pipe-clay-colored Stools.	Saffron or Porter-colored Urine.	Itching of the Skin.	Distended Gall-bladder.	Enlarged Liver.
Intra-hepatic duct...	1	2	—	—	3	—	—	—	—	—	—
Cystic duct.....	1	2	3	4	5	—	—	—	—	*	—
Hepatic duct	1	2	3	4	5	6	7	8	9	—	10
Common bile duct...	1	2	3	4	5	6	7	8	9	10	11

* Although the gall-bladder is in these cases never distended with bile, if the impaction be complete, and is continued sufficiently long, it may become distended by white mucus-secretion. For the *modus operandi* in the formation of white liquids in the gall-bladder, see the writer's book on "Diseases of the Liver, with and without Jaundice," where its physiology as well as pathology is given in detail.

Although the diagnosis of the presence of a biliary concretion is shown by the table, p. 867, to be reducible to almost a positive certainty, it is not on this account to be imagined that the differentiation of the various kinds of concretions (even when they are actively leading to an inevitable fatal termination) is equally easy. For, on the contrary, the various signs and symptoms produced by all the four different kinds of biliary concretions, when they occupy similar situations, are so very much alike that the task of differentiating between a gall-stone, inspissated bile, gravel, and biliary sand sometimes even baffles the expert specialist. And strange to say, not only has small biliary gravel proved in some cases as rapidly fatal as a large gall-stone, but even fine biliary sand has sufficed to produce as deadly an occlusion of the common bile duct as hard masses of inspissated bile itself. So that until the concretion, or part of the concretion, has come away and been chemically examined, it may be quite beyond human power to say what its real nature is. All that is possible to say with certainty being that it is a biliary concretion, in such or such a situation, that is giving rise to the symptoms. It happens, fortunately alike for doctor and patient, that the mere differentiation of the kind of biliary concretion which is giving rise to the dangerous symptoms is, comparatively speaking, a matter of minor importance; so long as its existence and its whereabouts have been correctly diagnosed. For the main object in treatment in all cases is to get the concretion out of the patient's body as speedily and with as little pain as possible. For the longer a biliary concretion—be its nature what it may—remains in the system, the bigger and bigger is it likely to become. And the larger it is, the more difficult is its extrusion, and consequently the greater is the danger of its leading to an ultimately fatal termination.

Vast as have been the improvements made within the last few years in abdominal surgery, one can scarcely as yet honestly say that the surgical removal of impacted biliary concretions has been attended with sufficiently satisfactory results to enable one "with a light heart" to recommend a patient to run the risk of the operation, unless the case appears to be otherwise utterly hopeless. For although gall-stones have again and again been safely removed by the surgeon's knife from the gall-bladder, it is most unfortunately

just when they are in that situation that they had much better, in by far the majority of cases, be left alone. For while lying free in the gall-bladder a gall-stone is in no case dangerous to life. It is only when it attempts to get out of it by ulceration, or permanently blocks up the biliary passages so completely as to totally obstruct the flow of bile into the intestines, that it actually endangers life, and it unfortunately happens that it is precisely those very cases which most frequently succumb after surgical interference. It is to be hoped, however, that the day is not far distant when surgeons will have so far improved their methods of procedure as to have reduced the percentage of mortality to a sufficiently low figure as to justify one in recommending the operation. Meanwhile, there is fortunately a way of getting not only sand, inspissated bile, and gravel, but even actual gall-stones, not bigger than small hazelnuts, out of the gall-bladder as well as the cystic and common bile ducts, without employing the knife; and that, too, merely, as about to be described, by a well-regulated system of digital manipulation through the intact abdominal parietes. Although I had for many years (the first successful case I ever had of finding a gall-stone after practising the process was in 1871, when three stones were found in the stools during a month's treatment; and although the patient lived for sixteen years afterward—she only died last year—she was never again troubled in the same way. The history of the case is given on page 665 of my book on "Diseases of the Liver," and it will be found to be well worth perusal, seeing that before I diagnosed it as one of gall-stones the patient was supposed to be dying of cancer, and being, accordingly, erroneously treated) in suitable cases of concretionary obstructive jaundice, practised this method of forcibly extruding the obstructing body from the biliary passages into the duodenum, from knowing that one can never feel certain that the obstructing body may not be in the very act of ulcerating its way out of the duct, and consequently render the operation dangerous, I hesitated publishing the method till 1886, when I alluded to it in a foot-note at p. 10 of my little book on inflammations of the liver,[1] in the following words: "As probably some of my readers may never have heard of my process of kneading, which I have successfully practised during the last few years, not only in cases of biliary sand and small gall-

stones, but likewise in renal calculi impacted in the ureters, I may as well mention that it simply consists in forcing the concretions in the one set of cases along the bile ducts into the intestines, in the other along the ureters into the bladder, by judiciously regulated digital pressure, the only cases in which kneading is counterindicated being those in which there is a tendency to ulceration of the ducts."

Since the above paragraph was published several have tried the method, and some have totally failed to derive any advantages from it. This non-success, however, has, I believe, arisen from their confounding it with the process of shampooing the abdomen—massage, as it is nowadays called—to which (as will be presently seen) it bears not the slightest resemblance.

So successful in my hands has proved this artificial mode of extruding biliary sand, gravel, and small calculi from both the gall-bladder and the bile-ducts, and getting them voided by stool, that it has now become with me a sort of routine form of practice. Rarely, indeed, does a day pass in which I do not try it on two or three suitable patients; and were I to relate only my more successful cases, without accompanying them with names and full details, so astounding would their results appear that I feel sure they would have but little chance of being credited by any not themselves the possessors of ingenuous minds. For example, would it be at all likely for a non-ingenuous-minded individual to believe that a gall-stone the size of a small hazelnut, supposed to have been for several months firmly impacted in the common bile-duct of a lady aged fifty-five, was, at the very moment that her death seemed imminent, safely extruded into the intestines after ten or twelve minutes' kneading of the distended gall-bladder, and not only voided by stool, but actually found in the chamber-pot within forty-four hours afterward? Fig. 2 is a drawing of the stone, of its natural size. Or would it not seem a mere fiction, were I to say that two facetted, sharp, angular-shaped gall-stones, the size of field-beans, were pushed out of the common bile duct, wherein a minute before they appeared as if immovably impacted, of a gentleman aged fifty-two, during the kneading process, which did not occupy above a quarter of an hour, and that the gentleman not only obtained immediate relief, but was himself able to search for and find one of them in the first

stool he afterward passed—which was in ten hours—and pick out the second stone from the next stool, voided exactly twenty hours after I had first seen him? Some facts are stranger than fiction, and these, strange as they no doubt appear to be, are indubitable facts, and what is more, facts that can be substantiated. Such cases as these of the incredible group I shall leave for the present, and proceed to narrate others from among the ordinary run of cases met with. The first I will relate is one possessing the exceptional advantage of having been seen by no less than nine other practitioners during the four or five years the patient was under my special medical care, among whom was a former President of the College of Physicians and two of our leading operating surgeons, so that there is no need of my giving names in order to

FIG. 2.

FIG. 3.

FIG. 2.—Gall-stone artificially extruded by digital manipulation from the common bile duct of a lady, aged fifty-five, and found in the stool forty-four hours after the operation. After having been supposed to have been impacted in the duct for nine months.

FIG. 3.—Two hard and sharp-cornered gall-stones artificially extruded from the common bile duct (in which they had been for three weeks firmly impacted) of a gentleman, aged fifty-two. The first stone being found in a stool passed ten hours, and the second found in one passed twenty hours after the first time digital manipulation was practised upon the patient. The drawings of them are of the natural size.

guarantee the truthfulness of its clinical history. Suffice it to say that the patient was a lady of about sixty summers and of high rank, who had during the previous twenty years of her life been treated for dyspepsia and flatulent colic by a number of different doctors. When first called to her bedside I diagnosed a gall-stone firmly impacted in the common bile duct; and as I proposed to subject her gall-bladder to digital manipulation, in order to force the impacted concretion out of the duct, it was arranged that as soon as possible she should proceed to London. The distance was only fifty miles, and yet such was the fatiguing effect the railway journey had upon her, that when she arrived in town she was in a state of collapse; from which she did not sufficiently recover to admit of my beginning the treatment for three days, and it was not until a week more had passed away that the impacted stone was successfully dislodged from the duct, and only after four

days more was it discovered in the stool. The stone, which was of the size of a small field-bean, proved on analysis to consist almost entirely of cholesterin; and although it was not facetted, there was no doubt in my mind that it was one of many. For I could feel the gall-bladder quite distinctly, as a hard ovoid body, the size of a man's fist, about three inches to the left of the umbilicus, and immediately below the enlarged liver. A daily course of digital manipulation of the gall-bladder was accordingly recommended and had recourse to, with the result that over seventy gall-stones were found in the stools during the subsequent seven months. At the end of that time, the gall-bladder appearing to have been completely emptied of all its calculi, the patient left for the country, and it is no exaggeration to say that soon afterward all the dyspeptic symptoms which she had suffered from for years previously disappeared. In this case rarely more than one gall-stone was voided at a time, though occasionally, after a biggish one had for six or seven hours blocked up the duct, and caused jaundice before coming away, two or three smaller ones rapidly followed its extrusion, without their producing any other symptoms than a trifling epigastric discomfort. It must be added that the calculi differed very much, both as regards their naked-eye appearances and chemical constitution, some being almost white, others brown, and not a few blackish green, differences no doubt arising from the stones having been formed at various times and under different conditions during the twenty or more years the patient had suffered from the biliary derangements which had not only been originally diagnosed, but always previously treated, as severe indigestions.

I will now refer to a case of an entirely different character, in which the operation was only had recourse to at distant intervals over a period of nearly two years, and where the stones, though varying from the size of a grape-seed to that of a small hazel-nut, were almost all of an identical color and composition. The case differs still further from the preceding, inasmuch as the calculi were extruded at irregular intervals and in runs from the gall-bladder. The patient, a Worcestershire gentleman, aged sixty-three, first came to me in 1886; and as I have unfortunately mislaid an admirable report of his case he kindly wrote out for me, I am compelled

to simply copy what is written on the label of the bottle containing his gall-stones, and append thereto a letter I received from him in February. The letter I send to the printer, with the request to print it exactly as it stands, omitting only the address and name of its writer. On the label of the bottle is, "Passed, after kneading, nineteen gall-stones up to the 18th August, 1886. 11th September, fifty-seven gall-stones. 4th December, eighty gall-stones." Besides these three specially recorded large groups of stones found in the stools, I also received from him at different times smaller groups, varying in number from three up to seven or eight. So that I calculate that this patient must have altogether passed, during the two years he was under treatment, not many less than 200 gall-stones! some of them, too, especially the three largest, being of a most unusually irregular shape, and with very sharp corners upon them. The last letter the patient sent to me runs as follows:

"*Feb. 6th*, 1888.

"At your request I now continue the history of my case (gall-stones) from the time I reported to you the passing of eighty stones in two months during the autumn of 1886. I am very thankful to say the history of the case since then is very short, consisting of only one severe turn I had in March, 1887, and being from home at the time, we could not ascertain what number of stones passed. Since then I have enjoyed excellent health, and though now sixty-five years of age, am as active as when I was forty. Having gone eleven months without an attack, I think I may fairly hope you have eradicated them."

Having finished my narrative of results, I shall now explain the mode of procedure.

In the first place it may be taken for granted that as almost all biliary concretions are formed in the gall-bladder, if the gall-bladder regularly emptied itself, as it ought to do, every day, the bile would never have the chance of becoming sufficiently concentrated to coagulate into masses; nor would any of its solid constituents find time enough to separate by precipitation from its fluids and assume the form of stratified calculi, nor any of its cholesterin be able to crystallize into sand, gravel, or gall-stones. In the second place the natural

exit of bile from the gall-bladder being by way of the cystic and common bile ducts into the intestines, even should, from some accident or another, minute concretions of any kind have found time to form in the gall-bladder, were all the bile daily extruded from it, the minute concretions would no doubt be at the same time extruded along with the bile, so long, at least, as they had not become sufficiently large to find a difficulty in getting into the cystic duct.

Let us now compare a human gall-bladder to a pear-shaped india-rubber syringe. We squeeze the syringe, and out flow its contents. And should it happen that the neck of the syringe or its canula has got blocked up by a piece of dirt, so long as the syringe is full of water, all we have to do is to give it a still smarter squeeze, so as to jerk the water against the obstructing body, and if the obstructing body be not too large it is suddenly dislodged and extruded along with the water. In this case we grasp the syringe with the hand; a proceeding not absolutely necessary, however, for if we merely forcibly press the two fore-fingers against the fundus of the syringe so as to involute its fundus—see Fig. 5—it will be equally compelled to expel its contents.

Turn now to the gall-bladder. We cannot grasp it in the hand through the intact abdominal walls, but as its fundus, when it is distended with bile, presses directly against the abdominal parietes—sometimes even to such an extent as to elevate them slightly, as is represented in Fig. 4—there is no difficulty whatever in applying pressure to the fundus of the gall-bladder by the tips of the fingers pressed against the integuments immediately over it. And just as in the case of the india-rubber syringe, the digital pressure applied to the fundus of the distended gall-bladder will be equally successful in making it expel its contents along the ducts into the intestines, in all cases where the obstructing body—be it inspissated bile, sand, gravel, or even a gall-stone—is sufficiently small as to be able to be propelled by the bile along the ducts into the intestines, as represented in Fig. 5.

Moreover, from the fact of the duct being dilatable, even impacted concretions as large as hazelnuts may be forced along them by daily judiciously applied slow and graduated pressure, especially when the dilating process is aided by the administration of medicines. There is always one point in

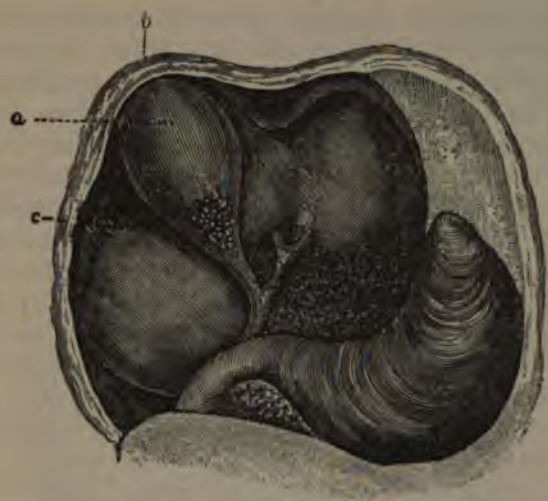

FIG. 4.—A gall-bladder so distended with bile (on account of duct obstruction) as to cause a slight elevation of the superjacent abdominal parietes, *b*; biliary concretions at the mouth of the cystic duct, *c*.

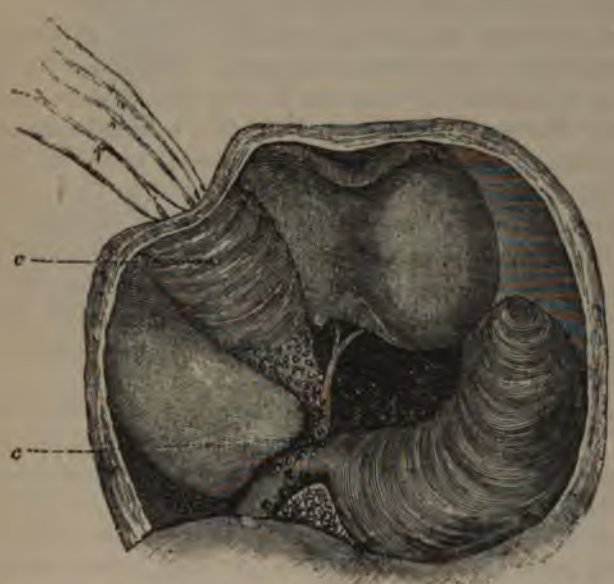

FIG. 5.—A distended gall-bladder being emptied of its contents by digital pressure on the abdominal walls. Showing the biliary concretions being extruded from the orifice of the common bile duct into the intestines. *b*.

favor of the operator, namely, that in cases where an obstruction to the flow of bile is caused by a biliary concretion, the gall-bladder is always more or less distended with fluid. And this has a double advantage, for, firstly, it renders the situation of the organ more easily detected, and secondly, there is plenty of bile in it for the operator to force against the obstruction and thus induce its forcible extrusion from the duct.

It may be as well for me to remark that although a distended gall-bladder is easily enough localized through thin abdominal parietes, its situation is not at all readily discoverable through fat ones, unless it be of large size; while a normal-sized gall-bladder, as it well known, is undetectable in either case.

In order to assist gentlemen in finding the gall-bladder, who are anxious to practise the above-described method of extruding gall-stones by digital pressure, I here subjoin an anatomical plate illustrating its usual position in a healthy individual. It is a copy of the woodcut given by Gaston (in his paper on duodeno-cholecystostomy),[2] which is itself, again, a slightly modified copy of Hinke's plate. Fig. 6.

Now, although the normal situation of the gall-bladder is here truthfully represented, one must not expect always to find it in this situation when the liver is enlarged or otherwise diseased. For sometimes the gall-bladder is found much nearer to, or much farther away from the mesial line. In a case I saw with Dr. Cook, of Forest Hill, on the 3d Oct., although the distended gall-bladder was beautifully distinct to the touch, it was both much nearer to the mesial line and to the umbilicus than is here represented. This arose from the cause of the occlusion of the duct being an organic growth, which in developing had pushed the gall-bladder from its normal position.

I would further beg to remind my readers that a few failures must not discourage them, as human fingers, like human eyes, require education; and that just as the trained eye of "the old salt" is not only able to detect on the horizon a vessel, but also to discover her rig, and probably even make a tolerably good guess at her tonnage, long before the uneducated eyes of the landsman can so much as perceive a dark speck in the distance, they are not to abandon their design on account of being at first unsuccessful. For, without doubt,

perseverance and opportunity will, in the end, enable them to discover gall-bladders, equally as readily as the trained fingers of the expert do, even through abdominal parietes so thick that untrained hands cannot so much as make out the boundary of the solid liver through them. While, again, they will find that ultimately they will be able to extrude small impacted biliary concretions—be they in the shape of sand, gravel, or stones—from the bile duct into the duodenum with

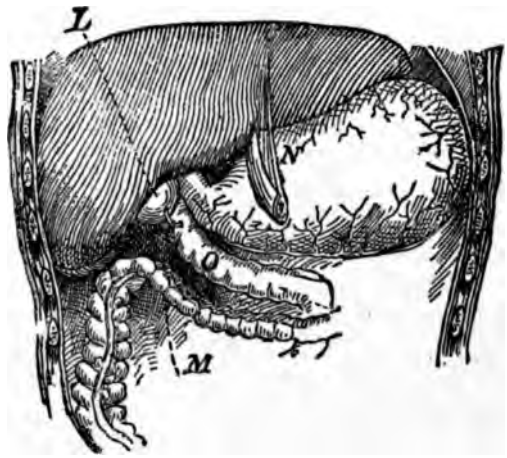

FIG. 6.—*L*, The gall-bladder of normal size and position; *O*, duodenum; *M*, the colon; *N*, suspensory ligament.

as much certainty and safety as they can pass a catheter through a stricture into a human urinary bladder. At the same time, for the sake of their patients' welfare as well as their own reputation, they must never forget to be as careful in the mode of operative procedure in the one case as they would be in the other, as neither the one nor the other operation is invariably unattended by danger.

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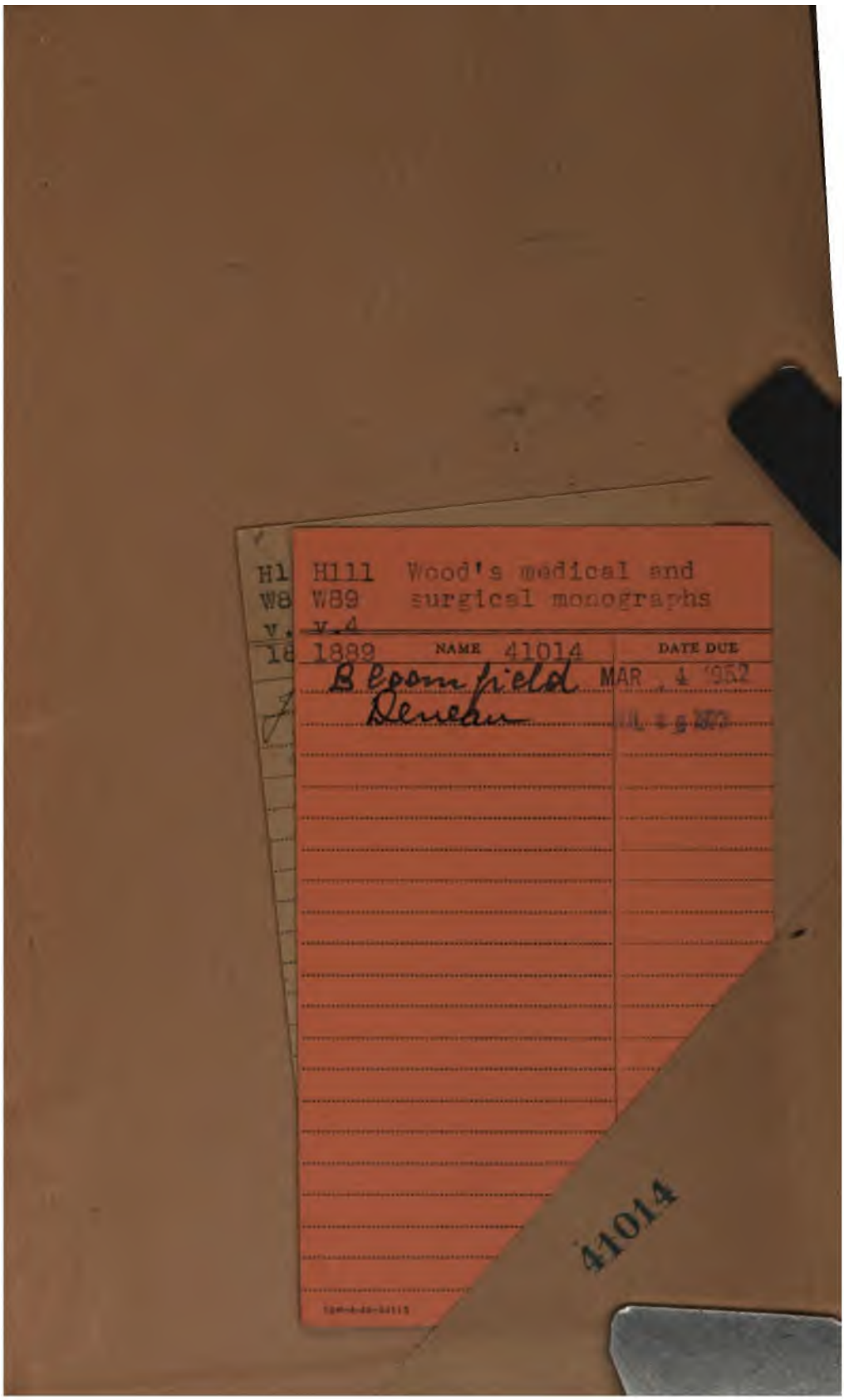
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